Cornell University Announcements

Graduate School of Medical Sciences 1984 • 1985

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Academic Calendar 1984–85

1984

Labor Day Holiday	Monday, September 3
Registration for first trimester* and Fall semester**; orientation for new students	Tuesday and Wednesday, September 4 and 5
First trimester and Fall semester begin	Thursday, September 6
First trimester ends	Wednesday, November 14
Examinations for first trimester	Thursday, November 15–Wednesday, November 21
Thanksgiving recess	Thursday and Friday, November 22 and 23
Registration for second trimester*	Wednesday, November 21, and Monday, November 26
Instruction begins for second trimester	Monday, November 26
Winter recess: Instruction suspended, 5:00 p.m.	Friday, December 14

1985

Winter recess: Instruction resumed, 9:00 a.m.	Wednesday, January 2
Last day for completing requirements for January degrees	Wednesday, January 9
Conferral of January degrees	Wednesday, January 23
Fall semester ends	Friday, January 25
Spring semester begins	Monday, January 28
Second trimester ends	Friday, February 15
Washington's Birthday observed	Monday, February 18
Examinations for second trimester	Tuesday, February 19–Friday, March 1
Registration for third trimester	Friday, March 1, and Monday, March 4
Third trimester begins	Monday, March 4
Spring recess:	
Instruction suspended, 5:00 p.m.	Friday, March 29
Instruction resumed, 9:00 a.m.	Monday, April 8
Fifth Annual Vincent duVigneaud Memorial Research Symposium	Tuesday, May 7
Last day for completing requirements for May degrees	Friday, May 17
Commencement Day; conferral of May degrees	Wednesday, May 22
Third trimester and Spring semester end	Friday, May 24
Memorial Day Holiday observed	Monday, May 27
Examinations for third trimester	Tuesday, May 28–Friday, May 31

*for students enrolling in courses

**for students conducting research only, who are on leave of absence, or are in absentia

Summer Term 1985

Registration for summer research term	Monday, June 3
Summer research term begins	Monday, June 3
Last day for completing requirements for August degrees	Monday, August 12
Summer research term ends	Friday, August 23
Conferral of August degrees	Monday, August 26

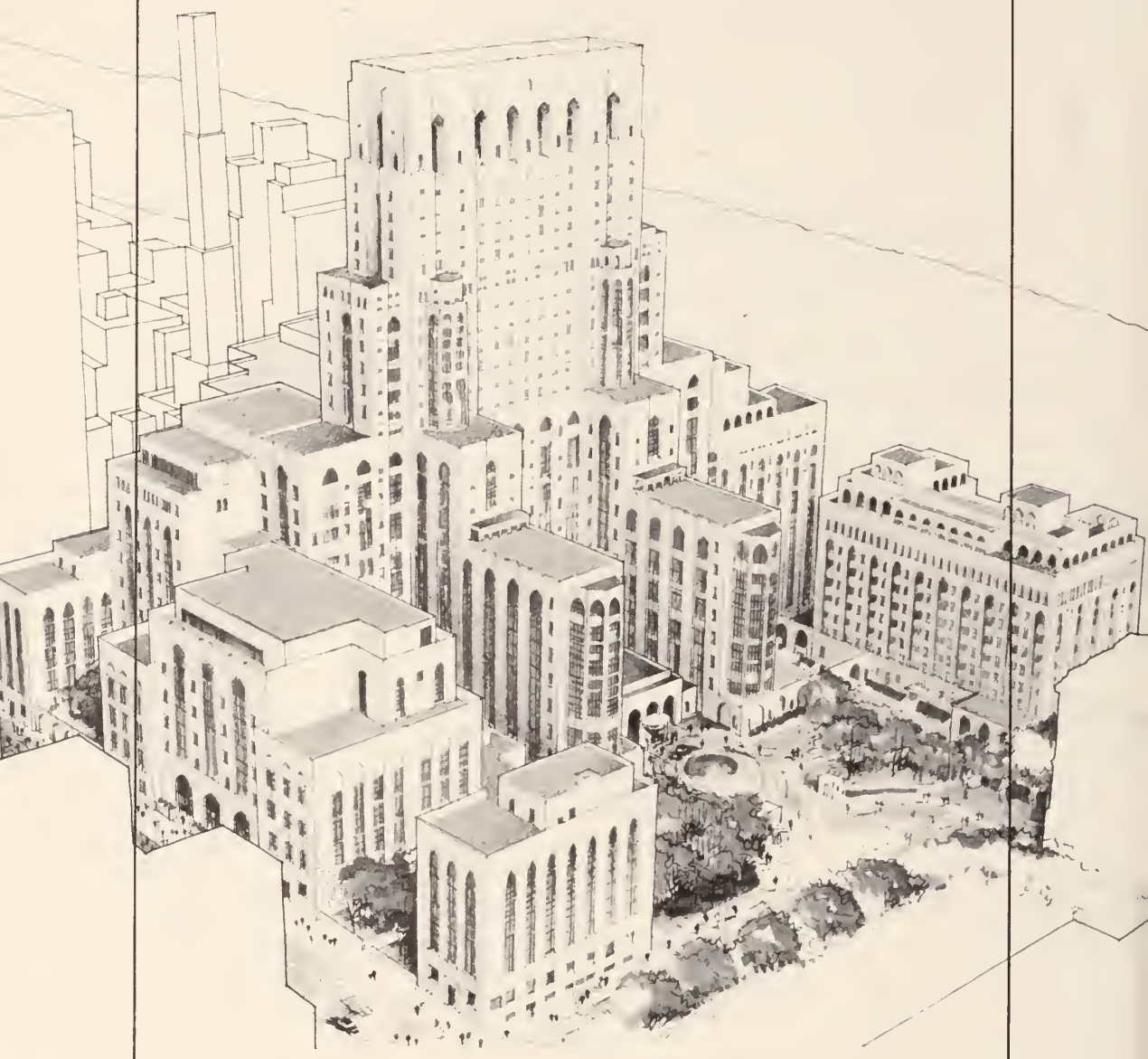
Note: Courses are trimestral; degrees are granted at ends of the Fall and Spring semesters and of the summer term. The dates shown in the calendar are subject to change at any time by official action of Cornell University.

In enacting this calendar, the Graduate School of Medical Sciences has scheduled classes on religious holidays. It is the intent of the school that students missing classes due to the observance of religious holidays be given ample opportunity to make up work.

Contents

The courses and curricula described in this Announcement, and the teaching personnel listed herein, are as of July 1, 1984 and are subject to change at any time by official action of Cornell University.

Cornell Medical Center



Cornell University
Graduate School of Medical Sciences

Purpose

The Graduate School of Medical Sciences, a semi-autonomous component of the Graduate School of Cornell University, provides opportunities for advanced study and research training in specific areas of the biomedical sciences. Graduate programs leading to the degrees of Doctor of Philosophy are offered in biochemistry, biophysics, cell and developmental biology, developmental therapy, genetics, immunobiology, molecular biology, microbiology, neurobiology and behavior, pathology, pharmacology, physiology, and virology. Certain of these fields of study also offer programs leading to the degree of Master of Science. Collaborative programs with Cornell University Medical College lead to the combined degrees of Doctor of Philosophy and Doctor of Medicine.

The faculty of the Graduate School of Medical Sciences recommends the award of advanced general degrees not only as the result of the fulfillment of certain formal academic requirements, but also as evidence of the development and possession of a critical and creative ability in science. Demonstration of this ability is embodied in a dissertation which the candidate presents to the faculty as an original research contribution in the chosen area of study.

A close working relationship between student and faculty is essential to the program of the Cornell University Graduate School of Medical Sciences. Guidance for each student is provided by a Special Committee, a group of at least three faculty members selected by the student. This Special Committee is granted extraordinary independence in working with its student. Other than a broad framework of Graduate School of Medical Sciences requirements for residence, examinations, and a thesis, and additional requirements of the particular field of study chosen by the student, the Special Committee is free to design an individualized program of study with its student. No overall course, credit-hour, or grade requirements are set by the Graduate School of Medical Sciences. A student is recommended for a degree whenever the Special Committee judges the student qualified.

History

The opportunity for graduate study leading to advanced general degrees in the biomedical sciences was first offered at the Cornell University Medical College, in cooperation with the Graduate School of Cornell University, in 1912. In June of 1950, Cornell University, in association with the Sloan-Kettering Institute for Cancer Research, established additional opportunities for graduate study

by forming the Sloan-Kettering Division of the Medical College. The resulting expansion of both graduate faculty and research training opportunities on the New York City campus prompted the organization in January 1952 of the Graduate School of Medical Sciences, composed of two cooperative but separate divisions, known as the Medical College Division and the Sloan-Kettering Division. The Graduate School of Medical Sciences was given full responsibility for advanced general degrees granted for study in residence at the New York City campus of Cornell University.

Facilities

Despite the divisional structure of the Graduate School of Medical Sciences, the courses offered by the two Divisions are open to all students, as are the general facilities of the Divisions such as libraries, dining halls, and recreational resources.

The Medical College Division. The buildings along York Avenue between 68th and 70th Streets accommodate both Cornell University Medical College and the Medical College Division of the Graduate School of Medical Sciences. Facilities available to graduate students include the Samuel J. Wood Library with a collection of over 127,000 volumes and subscriptions to 1,970 current journals, lecture rooms, study laboratories, seminar rooms and libraries of the basic science departments. Extensive research facilities are provided for faculty and students.

The Sloan-Kettering Division. Its facilities are located within the Sloan-Kettering Institute for Cancer Research, which consists of the Howard, Kettering, and Schwartz Laboratory buildings on East 68th Street. In addition, the Walker Laboratory is located in Rye, New York. Each provide lecture and seminar rooms, and together represent more than 100 laboratories, which are available for biomedical research training. The Lee Coombe Memorial Library with 23,600 volumes of books and journals is located in the 68th Street complex.

Organization

The faculty of the Graduate School of Medical Sciences is composed of the faculties of the Medical College Division, consisting primarily of the professional staff of the basic sciences departments of Cornell University Medical College, and of the Sloan-Kettering Division, consisting of those professional staff members of the Sloan-Kettering Institute for Cancer Research who hold faculty appointments.

Within each of the Divisions are Fields (Medical College Division) and Units (Sloan Kettering Division) of graduate instruction which are formed by

the faculty members in the respective Divisions with similar research and teaching interests. These Fields and Units of the Graduate School of Medical Sciences represent areas of concentration in which advanced degrees are offered.

Executive Committee

The Executive Committee is both the administrative and judicial board of the Graduate School of Medical Sciences and its members have continuing responsibility for the academic affairs of the school. The Committee is composed of the Chairpersons of the basic science departments of the Medical College Division and of the Programs of the Sloan-Kettering Division, the Directors of the Interdisciplinary Fields, the Dean and Associate Dean, the Provost for Medical Affairs of Cornell University, the Director and Associate Director of the Sloan-Kettering Division, the Chairperson and Vice-Chairperson of the Faculty Advisory Committee (see below), and two non-voting, elected student representatives.

The Executive Committee considers such matters involving the interests and policies of the Graduate School of Medical Sciences as are referred to it by the Faculty Advisory Committee, by individual members of the Faculty, or are generated upon its own initiative. The Committee approves the addition or deletion of fields of study, reviews the admission of students, approves student's major and minor fields, reviews the curriculum and requirements for degrees.

The Executive Committee is chaired by the Dean, who is the academic administrative officer of the Graduate School of Medical Sciences and is also an Associate Dean of the Graduate School of Cornell University. The Secretary of the Executive Committee is the Associate Dean, who is also an Assistant Dean of the Graduate School of Cornell University.

Faculty Advisory Committee

The Faculty Advisory Committee is the primary body representing the views of the Faculty of the Graduate School of Medical Sciences. The Committee advises the Dean and the Executive Committee on the impact of educational and policy matters under their consideration and recommends changes in educational activities, procedures, and policy of the Graduate School of Medical Sciences.

The Faculty Advisory Committee is composed of one elected faculty representative of each Field of the Medical College Division and of each Unit of the Sloan-Kettering Division, and one elected student representative from each Division. The Chairperson and Vice-Chairperson of the Committee are elected by its membership. Non-voting members are the Dean and Associate Dean, the Provost for Medical Affairs of Cornell University, and the Director and Associate Director of the Sloan-Kettering Division.

Special Programs

Medical Scientist Training Programs (M.D.–Ph.D.)

These programs are designed to expose a student to both medical and graduate disciplines during a six-year course of study. The combination of skills in basic research and experience in a clinical setting will prepare graduates from this program to pursue investigative careers in the biomedical sciences or in clinical medicine. The student spends the first two years as a medical student studying the basic medical sciences and attending regular graduate seminars. The summer months are spent in the laboratory learning experimental techniques and doing research. The third, fourth, and fifth years of the student's program are spent as a full-time graduate student and are devoted mainly to laboratory research and writing the thesis. The sixth year of the program is devoted to clinical clerkships. This six-year program represents the minimum time required to satisfy residence requirements of both the M.D. and Ph.D. degrees at Cornell University. Successful applicants to the program will become M.D.–Ph.D. Fellows and will receive a full tuition scholarship and a stipend covering living expenses for the six-year period.

Separate Medical Scientist Training Programs are offered by the Medical College and Sloan-Kettering Divisions:

M.D.–Ph.D. Program at the Medical College Division: Preclinical and clinical training are provided by the faculty of Cornell University Medical College, while graduate education in research is offered by the faculty of the Medical College Division of the Cornell University Graduate School of Medical Sciences.

M.D–Ph.D. Program at the Sloan Kettering Division: This program is sponsored collectively by the Sloan-Kettering Division, the Rockefeller University, and Cornell University Medical College. The program requirements include the research-based Sloan-Kettering Division Ph.D. curriculum, the Cornell University Medical College curriculum, and a number of tri-institutional special learning opportunities designed specifically for the Medical Scientist candidates.

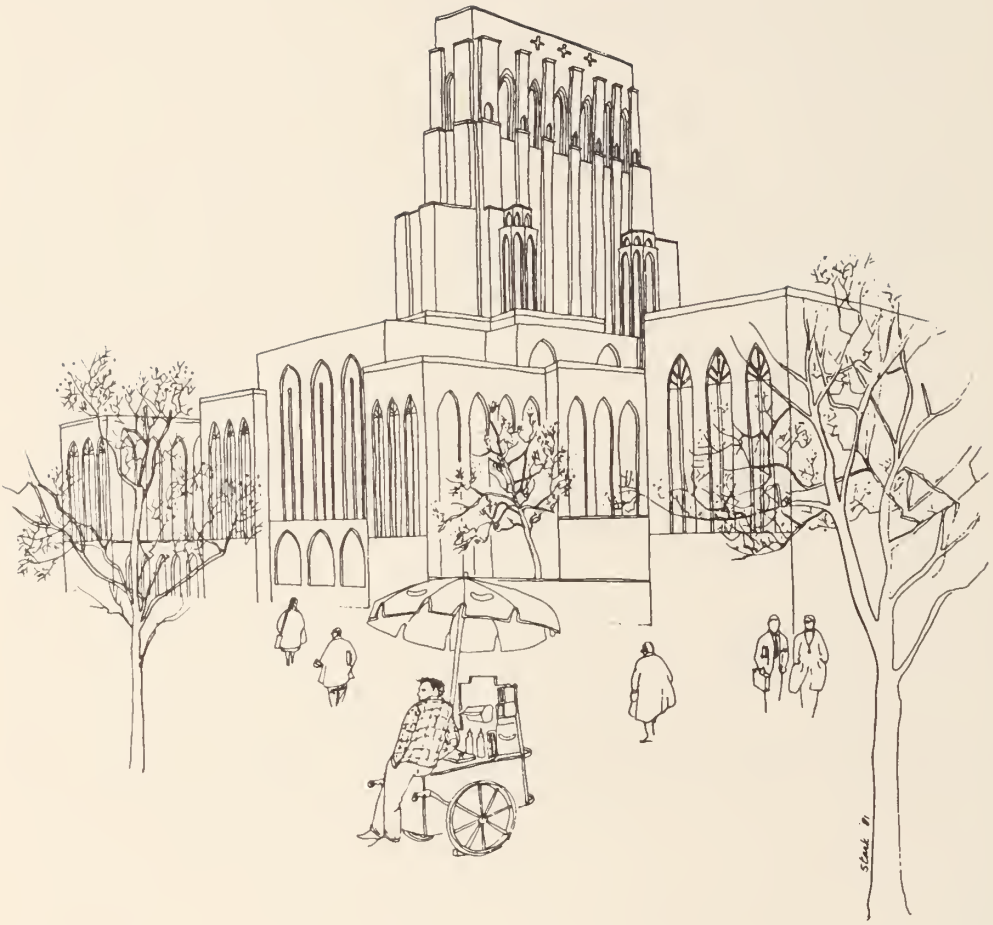
For application to these programs, see p. 68.

Ph.D.–M.D. Program

Students enrolled in the Graduate School of Medical Sciences may be eligible for admission into the Ph.D.–M.D. Program, jointly sponsored by the Medical College and the Graduate School of Medical Sciences. This program is designed for those graduate students who find that their teaching and research goals require the acquisition of the M.D. degree in addition to the Ph.D. degree. The program is *not* designed as an alternate path for students who have the M.D.

degree as their primary goal, but who have not been accepted by a medical school. Those who know, at the time of application to Cornell, that they want to pursue a course of study leading to both degrees should apply to one of the M.D.–Ph.D. programs described above.

See p. 69 for application and graduation requirements of the Ph.D.–M.D. program.



Faculty and Research Activities

Medical College Division

Field of Biochemistry

Faculty

John P. Blass
Adele L. Boskey
Esther M. Breslow
Arthur J.L. Cooper
Gordon F. Fairclough
Jerald D. Gass
Helena Gilder
Jack Goldstein
Owen W. Griffith
David Hajjar
Rudy H. Haschemeyer
Bernard L. Horecker
Chun-Yen Lai
Raymond E. Lockard
Alton Meister
Ursula Muller-Eberhard
Abraham Novogrodsky
Aaron S. Posner
Julian R. Rachele
Robert R. Riggio
Albert L. Rubin
Brij B. Saxena
Edward T. Schubert
Richard L. Soffer
Kurt H. Stenzel
Suresh S. Tate
Sidney Udenfriend
Daniel Wellner
Kenneth R. Woods
David Zakim

Research Activities

Members of the field of Biochemestry are engaged in research spanning a wide spectrum of scientific areas. Thus, the research in *Dr. Meister*'s laboratory is concerned with the study of enzymes, especially those involved in amino acid, peptide, and protein metabolism. It involves the isolation of enzymes, the determination of their structure and properties, and the use of techniques such as isolation of mRNA and cDNA. The research is basic in nature, but significant relationships between this research and human disease have been discovered and are also being explored. Current work involves the metabolism and function of glutathione, including the relationships of this tripeptide to transport, metabolism, radiation, and chemotherapy.

Research in *Dr. Haschemeyer*'s laboratory concentrates on the development of physical methods to study molecular structure and interactions, and on the application of such methods to ascertain structure-function relationships in selected systems. Current emphasis is directed toward computer modeling of biological flow methods and heterogeneous-phase reactions and on immuno-electron microscopy of human serum lipoproteins.

Dr. Breslow is concerned with understanding, in a quantitative sense, the forces that determine the specificity of protein-protein interactions. She has been studying the interactions of the pituitary peptide hormones, oxytocin and vasopressin, with their storage protein, neurophysin. These studies are directed towards elucidating the binding site regions of the hormones and of the protein and at quantitating the energies of different components of the interaction. A second research project concerns the mechanism by which proteins are degraded intracellularly during normal protein turnover. The aims of these studies are to understand the precise role of ubiquitin, a small protein known to be involved in this process, and to elucidate the mechanisms underlying the selection of proteins for degradation.

Current interest in *Dr. Tate*'s laboratory is focused on the isolation, characterization, and ultrastructural localization of enzymes responsible for the formation of modified N- and C-terminal residues of peptide hormones in the hypothalamus and the pituitary gland. Synthetic peptide substrates are being used to identify and isolate an enzyme from bovine pituitary glands which is responsible for the formation of the C-terminal amide group of several hormones. In another project, three brush-border enzymes are being used as model systems to gain an understanding of the processes involved in the assembly of the highly specialized microvillus membranes. The enzymes under study are γ-glutamyl transpeptidase, a dipeptidase, and aminopeptidase M. Current work includes a study of structure-function relations in these enzymes, their biogenesis, post-translational processing and sorting, and achievement of their final intracellular location.

Dr. Griffith's research involves the design, synthesis and utilization *in vivo* of enzyme-selective inhibitors and substrates. These compounds are used both to evaluate and to control the metabolite flux through various pathways in intact animals. Recent studies have focused on the manipulation of glutathione and cysteine metabolism. Enzyme-selective inhibitors were developed that allow both glutathione biosynthesis and utilization to be blocked; techniques allowing extracellular cystine formation to be controlled were also developed. The inhibitors were shown to be useful in treating animal trypanosomiasis, enhancing oxidative killing of tumor cells, and preventing the formation of leukotriene C. New inhibitors are now being developed to allow *in vivo* control of carnitine metabolism. Applications of these compounds include the investigation and therapy of inherited diseases of lipid metabolism and diabetes.

Research in *Dr. Wellner*'s laboratory is concerned with the structure and function of enzymes involved in amino acid metabolism, such as L-amino acid oxidase and threonine deaminase. Amino acid analyses of urine and blood of patients with inherited and acquired defects in amino acid metabolism are carried out as part of an effort to improve the diagnosis and treatment of these diseases.

Dr. Lockard's research is directed towards understanding cytoplasmic con-

trol of eukaryotic gene expression. He is investigating the role of messenger RNA conformation in translational control and mRNA turnover. He is also studying the primary structure of rabbit 18S ribosomal RNA and its topography within the 40S subunit.

Dr. Cooper's laboratory is working in the area of α-keto acid biochemistry and pyridoxal phosphate enzymes. Another area of active research is the metabolism of amino acids and ammonia in the brain. For this purpose, molecules labeled with short-lived radioisotopes are synthesized and their distribution in brain is analyzed by positron emission tomography. Cerebral energy metabolism, with particular emphasis on the malate-aspartate shuttle, and its disruption in various disease states is also being investigated.

Dr. Horecker is working on the isolation and characterization of peptides from the thymus gland and evaluation of their possible function as hormones that regulate cellular immunity. The cloning of the genes for thymosin β 4 and for prothymosin γ is a major current objective. Another project concerns the role of intracellular proteinases in the regulation of cellular processes, including their function in the turnover of intracellular proteins and in the cytotoxic effects of human lymphocytes.

Dr. Stenzel and *Dr. Novogrodsky* are interested in determining the molecular mechanisms involved in lymphocyte activation induced by the mitogenic oxidizing agents, sodium periodate and galactose oxidase. They are studying structural and functional alterations in cells rendered stimulatory by the oxidizing mitogens. These investigations include an analysis of the membrane sites oxidized and the possible cross-linked structures formed. Attempts are made to determine the requirements for stimulatory activity by reconstruction of stimulatory structures using hybridization and fusion techniques. They are also investigating structural and functional alterations in cells responsing to aldehyde-modified stimulatory cells and cell fractions, and their requirements for soluble growth factors.

Studies are currently in progress in *Dr. Hajjar*'s laboratory to investigate the interaction of endothelial cells which line blood vessels with the underlying smooth muscle cells in an attempt to define the role of the endothelium in the process of cholesterol accumulation during arteriosclerosis. In addition, the role of herpes viruses as an etiological agent in the pathogenesis of lipid accumulation and arteriosclerosis is under investigation by studying the virus' effects on intracellular cholesterol metabolism and lipoprotein binding and metabolism.

The main objective of *Dr. Soffer*'s research is to characterize the physical, chemical, and biochemical properties of angiotensin II receptor which has been purified to a nearly homogeneous state from rabbit hepatic membranes.

Dr. Posner is studying bone mineral structure and properties with emphasis on the elucidation of the biochemical processes of tissue mineralization. Techniques such as x-ray diffraction, electron microscopy, and infrared absorption spectrophotometry are used in this project. The role in the mineralization pro-

cess of the organic constituents of bone, such as collagen and proteoglycans, is of prime interest.

Dr. Boskey's research is concerned with elucidating the factors controlling physiologic and dystrophic calcification. Hydroxyapatite formation and growth is studied in solution, in collagen gels, and in animal tissues. Recent studies have concentrated on the mechanism of action of proteoglycans (a mineralization inhibitor) and acidic phospholipids (promoters of mineralization). Studies are also in progress on the role of vitamin D metabolites in bone lipid metabolism.

Dr. Lai's research is concerned with the structure and function of cholera toxin. Work from his laboratory has shown that subunit A1 of cholera toxin is fully responsible for the toxin's ability to stimulate adenylate cyclase in mammalian cells. Isolated subunit A1 was also shown to catalyze an efficient transfer of the ADP-ribose moiety from NAD to a membrane protein. In another project, evidence has been obtained for a two-domain structure of the angiotensin converting enzyme: the hydrophobic carboxy-terminal portion of the enzyme is anchored to the cell membrane and the amino-terminal half, with the active site, is exposed to the blood circulation. Structural analyses indicate that the lung and testis enzymes may be the products of two distinct genes, and experiments are in progress to explain the close similarities between the two enzymes.

Dr. Muller-Eberhard is investigating the mechanisms of transport of iron protoporphyrin IX and its metabolic precursors by proteins in the blood stream as well as within hepatocytes. She is studying the exchange of porphyrins between proteins purified from serum and from hepatocytes; developing methods which delineate the function of these proteins in the delivery of porphyrins to hepatocytes and their intracellular distribution; and assessing the interaction of these proteins with artificial and biological membranes to learn how they may facilitate ligand transport across cellular and intracellular barriers.

Dr. Goldstein is studying the structure and function of erythrocyte surface antigens and is working on enzymatic methods for the removal of immunodominant sugars responsible for blood group A and B activity.

Dr. Blass' research concerns cell biologic-metabolic aspects of degenerative diseases of the nervous system and focuses on the role of the pyruvate dehydrogenase complex (PDHC). Among other findings, a decrease in apparently normal PDHC antigen and activity was found in histologically normal areas of brain from patients with Alzheimer disease, and a structural abnormality in the E3 (LAD) component of PDHC in Leigh disease, which impairs the assembly of the complex.

Recent Publications

Blass, J.P. (with Sheu, K.-F.R., and Lai, J.C.K.), Pyruvate dehydrogenase phosphate phosphatase in brain: Activity, properties, and subcellular localization. J. Neurochem. 40:1366–1372, 1983.

Blass, J.P. (with Sheu, K.-F.R., and Lai, J.C.K.), Properties and regional distribution of pyruvate dehydrogenase kinase in rat brain. J. Neurochem. 42:230–236, 1984.

Boskey, A.L. (with Chen, C-C., and Rosenberg, L.C.), The inhibitory effect of cartilage proteoglycans on hydroxyapatite growth. Calcif. Tissue Int. 36:285–290, 1984.

Boskey, A.L. (with Timchak, D.M.), Phospholipid changes in the bones of the vitamin D-deficient, phosphate-deficient, immature rat. Metab. Bone Dis. and Rel. Res. 5:81–85, 1983.

Breslow, E. (with Sardana, V.), Proton magnetic resonance and binding studies of proteolytically modified neurophysins. J. Biol. Chem. 259:3669–3679, 1984.

Cooper, A.J.L. (with Fitzpatrick, S.M., Ginos, Z., Kaufman, C., and Dowd, P.), Inhibition of glutamate-aspartate transaminase by β-methylene-DL-aspartate. Biochem. Pharmacol. 32:679–689, 1983.

Cooper, A.J.L. (with Fitzpatrick, S.M., and Duffy, T.E.), Use of β-methylene-DL-aspartate to assess the role of aspartate aminotransferase in cerebral oxidative metobolism. J. Neurochem. 41:1370–1383, 1983.

Goldstein, J., Biochemical manipulation of blood groups. In: Clinics in Immunology and Allergy, van Rood, J.J., de Vreis, R.R.P., eds., W.B. Saunders, London, Vol. 4, No. 3, in press.

Goldstein, J. (with Kuo, K-Y.), α-D-galactosidase immobilized on a soluble polymer. Enzyme Microb. Technol. 5:285–290, 1983.

Griffith, O.W., Cysteinesulfinate metabolism: Altered partitioning between transamination and decarboxylation following administration of β-methylene-DL-aspartate. J. Biol. Chem. 258:1591–1598, 1983.

Hajjar, D.P. (with Weksler, B.B.), Metabolic activity of cholesteryl esters in aortic smooth muscle cells is altered by prostaglandins I_2 and E_2. J. Lipid Res. 24:1176–1185, 1983.

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Horecker, B.L. (with Pontremoli, S., Melloni, E., Salamino, F., Sparatore, B., and Michetti, M.), Cytosolic Ca^{2+}-dependent neutral proteinases from rabbit liver: Activation of the proenzymes by Ca^{2+} and substrate. Proc. Natl. Acad. Sci. U.S.A. 81:53–56, 1984.

Horecker, B.L. (with Wodnar-Filipowicz, A., Gubler, U., Furuichi, Y., Richardson, M., Nowoswiat, E.F., and Poonian, M.S.), Cloning and sequence analysis of cDNA for rat spleen thymosin B_4. Proc. Natl. Acad. Sci. U.S.A. 81:2295–2297, 1984.

Lai, C-Y. (with Xia, Q-C., and Salotra, P.), Location and amino acid sequence around the ADP-ribosylation site in the cholera toxin subunit A_1. Biochem. Biophys. Res. Commun. 116:341–348, 1983.

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Meister, A. (with Anderson, M.E.), Glutathione. Ann. Rev. of Biochem. 52:711–760, 1983.

Meister, A., Selective modification of glutathione metabolism. Science 220:471–477, 1983.

Muller-Eberhard, U. (with Pasternack, R.F., Gibbs, E.F., Hoeflin, E., Kosar, W.P., Kubera, G., Skowroneck, C.A., and Wong, N.M.), Hemin binding to serum proteins and the catalysis of interprotein transfer. Biochemistry 22:1753–1758, 1983.

Muller-Eberhard, U. (with Fooidart, M., Liem, H.H., Adornato, B.T., and Engel, W.K.), Hemopexin metabolism in patients with altered serum levels. J. Lab. Clin. Med. 102:838–846, 1983.

Posner, A.S. (with McGann, T.C.A., Kearney, R.D., Buchheim, W., Betts, F., and Blumenthal, N.C.), Amorphous calcium phosphate in casein micelles of bovine milk. Calcif. Tis. Int. 35:821–823, 1983.

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Soffer, R.L. (with Sen, I., and Bull, H.G.), Isolation of an angiotensin II-binding protein from liver. Proc. Natl. Acad. Sci. U.S.A. 81:1679–1683, 1984.

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Wellner, D. (with Stoner, E., Starkman, H., Wellner, V.P., Sassa, S., Rifkind, A.B., Grenier, A., Steinherz, P.G., Meister, A., New, M.I., and Levine, L.S.), Biochemical studies of a patient with hereditary hepatorenal tyrosinemia: Evidence of glutathione deficiency. Pediatr. Res., in press.

Field of Cell Biology and Genetics

Faculty

Fred H. Allen
Vincent G. Allfrey
Rosemary F. Bachvarova
David M. Bader
C. Richard Minick
Ralph L. Nachman
Joel D. Pardee
David M. Phillips

Arthur Bank
Carl G. Becker
J. Michael Bedford
Dorothea Bennett
Calso Bianco
Adele L. Boskey
Dana C. Brooks
W. Ted Brown
Peter G. Bullough
Raju S. Chaganti
Moses Chao
B. Shannon Danes
Donald A. Fischman
James L. German III
Fakhry G. Girgis
Jack Goldstein
Lloyd H. Graf
Hans-Peter Hoffman
Barbara H. Hosein
Edward M. Johnson
Enrique M. Rabellino
Michael Risley
Toby C. Rodman
Enrique Rodriguez-Boulan
Pablo Rubenstein
Nurul H. Sarkar
Brij B. Saxena
Edward T. Schubert
Joan Rankin Shapiro
Selma Silagi
Marcello Siniscalco
Julio L. Sirlin
Gregory W. Siskind
Richard Sterner
Roy C. Swan
Paula Traktman
Steven S. Wachtel
Doris A. Wall
Babette B. Weksler
David Zakim

Research Activities

Research is conducted in virtually all major fields of cell biology and genetics with a broad range of methodologies and facilities available. Opportunities are often available for interested students to extend basic research to a clinical setting.

Research in basic cell biology includes the analysis of muscle, both skeletal and cardiac, with respect to control of gene expression, development, and the organization of proteins into myofibrils. In addition, mechanisms of cell motility, including control of assembly of actin filaments, are being studied in the simple organism *Dictyostelium*. Other research programs include studies of the mechanism of receptor mediated endocytosis using as an example the uptake of yolk by amphibian oocytes, and analysis of epithelial cell polarity, in particular the mechanism by which viruses are vectorially directed within the cell. Most of the above projects use a variety of methods including biochemical, immunochemical, recombinant DNA, cytological, and ultrastructural approaches to the problem.

Recombinant DNA techniques are particularly emphasized in projects involving the analysis of cell surface receptors, the mechanism of immunoglobulin heavy chain switching, replication of DNA in vaccinia virus as an example reflecting eukaryotic cell mechanisms, evolution of the multigene

immunoglobulin family, and regulation of gene expression and tumorigenicity in melanoma and neuroblastoma cell lines.

Cytogenetics and somatic cell genetics are important parts of the program in Genetics. Both techniques are being used in the analysis of inherited diseases which predispose to cancer, as well as the expression of mutant genes in cultured cell lines carrying these diseases. Cytogenetic approaches to visualize the effects of toxic agents and chemotherapeutic agents on the chromosomes of male germ cells are being developed. Somatic cell genetics as well as recombinant DNA techniques are being used to map the human genome, particularly the X chromosome.

Studies of mammalian development include an effort to understand the nature of mutations which affect embryonic development of the mouse using both classical genetics and recombinant DNA techniques. Storage of RNA transcripts in mouse oocytes and their fate during meiotic maturation and early development are being followed.

Reproductive biology is represented by studies of the physiology of the reproductive tract, studies of spermatozoa using functional and ultrastructural approaches, organization of chromatin in spermatozoa and oocytes, in vitro studies of cell interactions during spermatogenesis, and comparative reproductive biology.

Other areas represented in the field include immunology, transplantation and immunogenetics, structure and function of monocytes and platelets, analysis of the basis of cardiovascular disease, and gene amplificaiton as a mechanism of drug resistance in human tumor cells.

Recent Publications

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Field of Microbiology

Faculty

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Gregory W. Siskind
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Dieter H. Sussdorf
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Research Activities

Emphasis is given to the molecular biology of microorganisms as it underlies their replication and the mechanisms of microbial pathogenesis.

On one hand microbes are of interest because their simplicity renders them attractive model systems to study in order to understand the fundamental processes of life. On the other hand they are of intrinsic interest as subjects of study both as a distinctive life form and because of their impact on other forms of life as parasites and/or symbionts. Because of the rapid development of molecular biological techniques, in particular in genetic engineering, microbiologists are now in a uniquely favorable position to ask ever more meaningful and sophisticated questions about basic mechanisms and to then apply the answers to practical problems of infectious diseases. The interests of the faculty in the program in microbiology span the broad spectrum inherent in such an area of science as well as a broadly based comprehensive graduate scientific education. The specific interests of the Field faculty are outlined below.

Studies of viruses include genome structure, replication, recombination, and latent infection. Additionally, gene regulation and the dependence of defective viruses on helper virus functions are covered. Finally use of viruses as recombinant vectors for the insertion of specific genes into mammalian cells is also being studied.

Similar types of studies are being carried out with bacteria. Particular attention is being given to the use of bacterial plasmids as vectors and cloning vehicles for genetic analyses. Also at the molecular level new methods of site-specific mutagenesis are being developed. Special studies are directed toward elucidation of the mechanism of bacterial transformation. Mycoplasma are the subjects of studies on antigenic structure and pathogenesis. At a more applied

level are projects in clinical microbiology, in particular the instrumental characterization of bacteria.

Fundamental studies on recombination in fungi are ongoing. Fungi are among the simplest of the eukaryotes and thus offer an excellent opportunity to define basic genetic mechanisms in cells with true nuclei. Current investigations are both genetical and enzymological in nature and will greatly enhance our understanding of the basic genetic process by which two DNA molecules exchange nucleotide sequences and thus genetic information.

There is an extensive research program in parasitology. The three basic components of the program have to do with the mechanisms of intracellular survival, pathogenesis and virulence, design of antiprotozoal agents and antimetabolites, and the immune response to protozoal infection.

Finally part of the program involves the host reaction to infection in terms of the immune response.

Recent Publications

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Field of Neurobiology and Behavior

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Virginia M. Pickel
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Walter F. Riker, Jr.
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David A. Ruggiero
Jeri A. Sechzer
Gerard P. Smith
Peter E. Stokes
Gladys N. Teitelman
Robert Young

Research Activities

The Field emphasizes a multidisciplinary approach to the study of the nervous system since recent advances in the field of neuroscience have mainly required multiple approaches. The research interests of the faculty are diverse, but overlap and include the following.

(1) Molecular neurobiology and neuronal plasticity during growth and development; this includes biochemical and molecular biological approaches to the development and phylogeny of the nervous system, and mechanisms governing differentiation and phenotypic expression of neurotransmitter enzymes and peptides in the central and peripheral nervous systems.

(2) Growth of nerve and axonal transport of materials; this includes biochemical and physiological studies of optic nerve regeneration and axonal transport in non-mammalian systems.

(3) Regeneration and degeneration in the central nervous system: the focus is on the molecular mechanisms governing retrograde reaction, regeneration, degeneration and neuronal cell death in the central nervous system.

(4) Molecular genetics of neurospecific proteins, neurotransmitter enzymes and receptors; this includes structural analysis of genes coding for these proteins, gene regulation of autonomic neurons, including gene cloning, DNA sequencing, and quantitative analysis of transcription and translation.

(5) Biochemistry of amino acids, alpha-keto acids and energy metabolism in the brain; the emphasis is on suicide inhibitors and mechanisms to transport reducing equivalents, as well as on the use of positron emitting compounds to assess brain metabolism in man.

(6) Relation of oxidative, calcium and neurotransmitter metabolism during various disease states, including nutritional disorders, aging, hypoxia and Alzheimer's disease; these interactions are examined with rodent brains *in vivo* and *in vitro*, as well as with cultured skin fibroblasts from humans.

(7) Positron emission tomography of the human central nervous system; the metabolism and physiology of the nervous system, intracellular pH and other measures of cerebral function as assessed with a variety of positron emitting compunds.

(8) Central regulation of autonomic nervous system: central neuronal regulation of cerebral blood flow and metabolism, and neuroanatomical substrates of cardiovascular regulation.

(9) Synaptic organization of networks of identified neurons: biophysics of synaptic transmission.

(10) Neuropharmacology of sedative-hypnotic drug dependence.

(11) Cytochemistry and histochemistry of neurons; the studies include ultrastructural identification of synaptic interactions of brain; immunocytochemistry of nervous specific protein, peptides and neurotransmitter enzymes, and quantitative analysis of enzyme expression by immunohistochemistry.

(12) Neuroendocrine mechanisms of feeding behavior, motivated behavior, human disorders of eating, and of depression and psychiatric disorders; these studies include examination of the interaction of neurotransmitters and their relation to behavioral states.

(13) Neural mechanisms of learning and memory and neurobehavioral toxicology.

(14) Antidepressants; their effects on brain amine neurotransmitters and behavior in young adult and the elderly.

(15) Neuropsychological approaches to behavior; these studies emphasize that human brain dysfunction provides a unique vantage point for studying mechanisms of preception, memory, attention and language.

Recent Publications

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Field of Pathology

Faculty

Daniel R. Alonso
Carl G. Becker
Peter G. Bullough
John T. Ellis
David Hajjar
Aaron Kellner
C. Richard Minick
Carol K. Petito
Margaret J. Polley
Alfred M. Prince
Charles A. Santos-Buch
Laurence B. Senterfit
Marc E. Weksler

Research Activities

Research activities in the Field of Pathology include both basic and clinical research into the mechanisms and natural history of disease.

The principal research activities of the department are directed to the study of cardiovascular disease and how basic pathophysiologic processes such as inflammation, blood coagulation and perturbation of the immune system and its regulation contribute to arteriosclerosis and its complications and the pathogenesis of Chagas' Disease, or South American trypanosomiasis. Together, these diseases are the major causes of cardiovascular deaths worldwide.

Much of the research is carried out within the Department of Pathology, but involves extensive collaboration with investigators in other disciplines, including especially immunology and hematology. We are convinced that this interdisciplinary approach is essential to understanding disease mechanisms and also provides a unique opportunity to graduate students by increasing the intellectual diversity of the research program.

Because the Department of Pathology is also responsible for the clinical laboratory services of The New York Hospital, most of the faculty also have clinical responsibilities. We regard this as a major research resource because problems relating to the diagnosis, etiology, and mechanisms of progression of disease processes arise constantly. Presentation and discussion of these make up an important part of the educaitonal conferences within the department and of the course in Pathology. They also provide a never ending source of subjects and ideas for both basic and applied research.

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Field of Pharmacology

Faculty

Walter W.Y. Chan
Diane F. Felsen
Owen W. Griffith
Michiko Okamoto
Gavril W. Pasternak
Marcus M. Reidenberg

Raymond W. Houde
Charles E. Inturrisi
Robert F. Kaiko
Roberto Levi
Arlene Rifkind
Walter F. Riker, Jr.
Hazel H. Szeto

Research Activities

The faculty in the Field of Pharmacology engage in a diverse range of research. This affords an unusual breadth of opportunity for training. The principal research areas are:

Analgesic and Opioid Pharmacology: Research on narcotic and non-narcotic analgesic drugs extends from the molecular (receptor) level to the clinical level. Analgesics under investigation include the opioids, the cannabinoids, nonsteroidal antiinflammatory drugs and endorphins. Ongoing projects include development of new and sensitive methods for pharmacokinetic studies of parent drugs and their metabolites, characterization of subclasses of opioid binding sites and clinical trials of novel analgesics.

Biochemical Pharmacology and Toxicology: Polyhalogenated hycrocarbon toxicities are the focal point of study. Susceptibility of organisms to chemical toxicity during embryonic development, the role of cytochrome P-450 mediated mixed function oxidase and the arachidonate metabolites in the production of toxicity are being investigated.

Cardiovascular Pharmacology: The research in cardiovascular pharmacology covers two areas. One is on the role of cardiovascular dysfunctions in immediate hypersensitivity reactions and the other is on the clinical pharmacology of antiarrhythmic drugs. The heart is studied as a target organ in immunologic hypersensitivity reactions. The role of chemical mediators such as histamine, platelet activating factors, prostaglandins, leukotrienes and other arachidonate metabolites in immunologic hypersensitivity reactions are investigated in both human and sub-human cardiac tissues. Clinical trials of antiarrhythmic drugs include procainamide and its metabolite N-acetyl-procainamide, quinidine and lidocaine metabolites. Pharmacokinetics of these drugs and their principal metabolites are determined. Therapeutic efficacy and safety of these antiarrhythmics are evaluated in cardiac patients of various ages.

Endocrine and Renal Pharmacology: The research activities center on the interactions between the neurohypophysial hormones and prostaglandins in the uterus and the kidney. The role of oxytocin and prostaglandins in the genesis of preterm labor and the development of specific oxytocin antagonists as potential agents for the prevention of preterm labor are the major foci of research. Ongoing projects also include the study of the physiology of prosta-

glandins in primary dysmenorrhea and the pharmacology of nonsteroidal antiinflammatory drugs in the treatment of this menstrual dysfunction.

The pharmacology of natriuretic neurohypophysial peptides and their ability to release intrarenal prostaglandins are also being studied to evaluate their potential as antihypertensive agents. The metabolism and function of arachidonic acid and its metabolites in the kidney and the liver, and the role of thromboxane A2 in the pathology of unilateral ureteral obstruction are being actively pursued. Other current projects include investigation of the role of arachidonic acid metabolites in hypertension and in salt and water balance and studies of the function of hepatic enzymes and various hepatic cell types in the metabolism of arachidonic acid.

Neuropharmacology: Studies on the neuropharmacology of nerve endings center on the mechanisms of drug action on neurones, neuronal processes and synaptic systems in both the peripheral and central nervous system. Current work is concerned with the pharmacologic and functional characterization of motor nerve terinals innervating tonic and phasic skeletal muscle. Pharmacologic probes are employed for the definition of cholinergic sites on these motor nerve terminals and for the testing of the hypothesis that the primary anticurare and anti-myasthenic actions of facilitatory drugs are exerted prejunctionally by an action on slow current channels. The role of flucocorticoids in motor nerve ending function is being investigated. The possibility that steroids play a role in maintaining presynaptic function in the nervous system will be a focal point of study.

Another major area of study is the pharmacologic and neuropharmacologic bases of the physical dependence and withdrawal caused by general CNS depressants. Barbiturates and alcohol are the prototypes for study. A quantitative methodology for the pharmacologic characterization of physical dependence on these CNS depressants in animal models has been perfected in this laboratory. The approach to research is multidisciplinary involving a wide range of laboratory techniques including modern chromatographic methods for determination of drugs in biofluids and electrophysiologic techniques for monitoring central and peripheral neuronal responses.

Pre- and Neonatal Pharmacology: The primary research interest is the study of maternal-fetal pharmacokinetics and pharmacodynamics. The pregnant sheep provides a model for studying, throughout the last trimester, the relative roles of the placenta and the fetus in determining the extent of fetal exposure of maternally administered drugs. The research involves mathematical modeling of the maternal-fetal unit, the determination of drug clearances by the placenta and by the fetus *in utero*, and the ontogenesis of the fetal drug-metabolizing capacity.

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Field of Physiology and Biophysics

Faculty

Olaf S. Andersen
William A. Briscoe
Walter W.Y. Chan
Colin Fell
Gustavo F. Frindt
Daniel Gardner
Marvin C. Gershengorn
Bernice Grafstein
Roger L. Greif
Chin Ok Lee
Roberto Levi
Chiann-Tso Lin
Martin Lipkin
Thomas M. Maack
Daniel Nachshen
Lawrence Palmer
Thomas G. Pickering
Enrique M. Rabellino
Barbara Rayson
Henry Sackin
John L. Stephenson
Bernd W. Urban
Allan M. Weinstein
Erich E. Windhager

Research Activities

Dr. Erich Windhager's studies are centered on the elucidation of mechanisms of transport of ions by renal epithelial cells. Recently, he found that cytosolic Ca ion activity modulates membrane permeability to Na ions and that the level of this ion in the cell may be an important regulator of overall Na transport by kidney cells. The techniques used in Dr. Windhager's laboratory include: isolated perfused renal tubule segments, intracellular measurement of ions by ion selective electrodes, electrophysiological techniques, isolated

membrane techniques and renal physiological techniques. Collaborating with Dr. Windhager are *Drs. Heinz, Frindt* and *Lin.*

Dr. Grafstein investigates nerve regeneration and transport of material in nerve axons. She is presently studying regeneration of goldfish optic nerve. Some of the conclusions reached in the past years are: drugs that disrupt microtubules produce metabolic effects in axons which resemble those produced by axotomy; application to the nerve cell body of a drug that increases cyclic nucleotide synthesis promotes regeneration; increased synthesis of most transported proteins occurs during regeneration. Among others, Dr. Grafstein uses the following techniques: isotope tracer studies, electronmicroscopy, high resolution autoradiography, and biochemical techniques for identification of substances present in the nerve.

Dr. Maack studies quantitative aspects and mechanisms of renal handling of proteins. Main recent findings conclude that the disposal of absorbed proteins is dependent on an appropriate acid pH of lysosomes and that the absorption of albumin is a high capacity-low affinity endocytic transport process. In addition, he determined the functional characteristics of atrial natriuretic factor (ANF), a substance present in the heart which decreases blood pressure and increases salt excretion by the kidney. The techniques used in Dr. Maack's laboratory include: isolated perfused rat kidney, isolated tubule segments, and biochemical and physiological techniques.

Dr. Andersen is interested in the mechanisms by which ions cross membranes. His studies entail analysis of single channel permeability in lipid bilayers, with emphasis on the physical and chemical properties of proteins which serve as channels. Recently, Dr. Andersen succeeded in reconstituting Na channels obtained from brain tissue into lipid bilayers. Techniques used in Dr. Andersen's laboratory include: single channel analysis, electrophysiological measurements, and physio-chemical analysis.

Dr. Fell studies vasomotility and the action of drugs such as norepinephrine and acetyl choline in this process. He uses the technique of intravital microscopy of small arteries of the ear of rabbits and rats.

Neurophysiological studies of *Dr. Gardner* center on synaptic transmission. Recent discoveries were: 1) choline activates inhibitory acetylcholine receptors of *Aplysia* buccal ganglia, and 2) in one class of neurons, cholinergic postsynaptic potentials have dual-function, with early excitatory and late inhibitory phases. Techniques used in Dr. Gardner's laboratory include: electrophysiological methods and computer analysis.

Dr. Lee investigates mechanisms of cardiac conduction and contractility. He recently discovered that cardiac glycosides increase cardiac contractility by changing activities of calcium ions in isolated cardiac cells. Techniques used in Dr. Lee's laboratory include: isolated Purkinje fibers and intracellular recordings with ion selective electrodes.

Dr. Palmer's research focuses on the mechanism of transepithelial Na re-

absorption by tight epithelia, and the control of this process by hormones and other factors. The nature of the transport system facilitating sodium movement across the apical membrane of epithelial cells is being elucidated using the toad urinary bladder as a model epithelium. Techniques used in Dr. Palmer's laboratory include: current-voltage analysis, flux ratio analysis, patch-clamping, and electrophysiological techniques.

Dr. Nachshen's laboratory studies fundamental properties of presynaptic nerve terminals. Since calcium entry into the nerve terminal triggers the release of neurotransmitter substances, Dr. Nachshen is studying the detail of this process and how internal pH and intracellular calcium are related to neurosecretion. Techniques used in Dr. Nachshen's laboratory include: use of pinched-off nerve endings (synaptosomes), measurements of intracellular calcium with optical indicator substances.

Dr. Rayson's research activities center on the investigation of the regulation of Na-K/ATPase (Na pump) in kidney cells. Recent discovery include the finding that intracellular Na levels regulate the number of active Na-K/ATPase enzyme sites in outer medullary tubular segments of the kidney. Techniques used in Dr. Rayson's laboratory include: suspension of tubular segments of the kidney, biochemical techniques, and NMR.

Dr. Urban studies the effects of general anesthetics on peripheral nerve (squid giant axon). He is investigating the mechanism by which anesthetics change sodium and potassium currents in nerves and in this manner alter nerve conductivity. Techniques used in Dr. Urban's laboratory include: patch-clamping, electrophysiological techniques and lipid bilayers.

Dr. Weinstein is developing a mathematical model of proximal tubular function. He uses mathematical modeling and computer techniques.

Recent Publications

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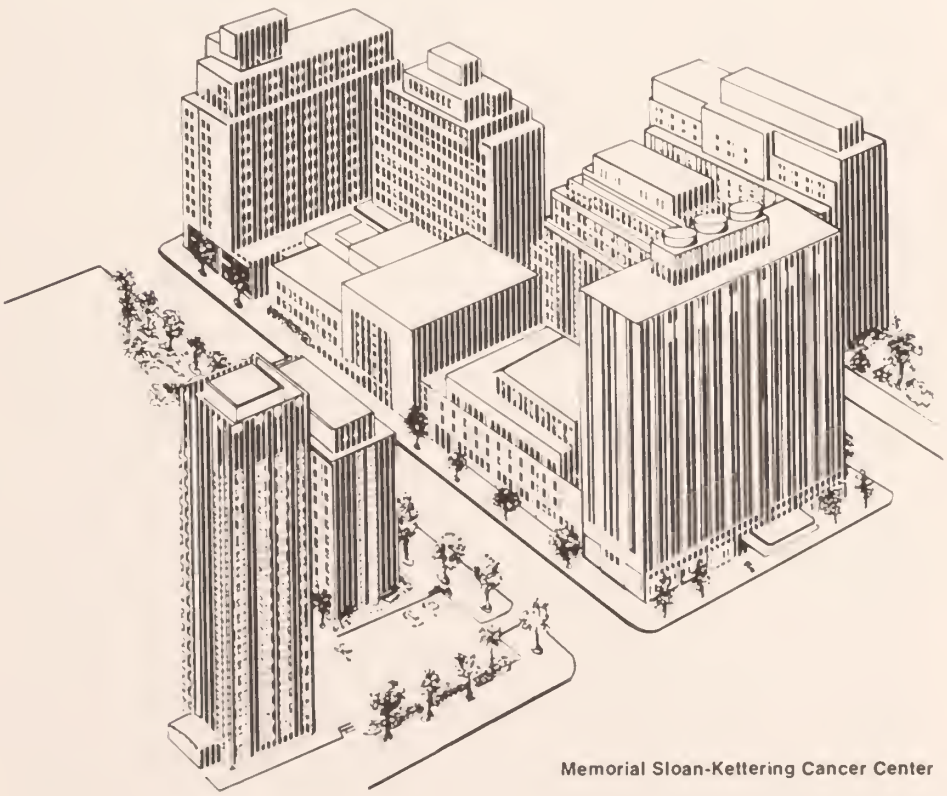

Memorial Sloan-Kettering Cancer Center

Sloan-Kettering Division

Unit of Cell Biology and Genetics

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Research Activities

Research in this program encompasses the areas of molecular genetics, cytogenetics, somatic cell genetics and developmental cell biology, including endocrinology. These studies are being pursued using the most modern cellular biologic, genetic, molecular biologic and immunologic methodologies.

Specific study is aimed at understanding cellular and molecular mechanisms that control coordinated gene expression and cell proliferation during induced cell differentiation, changes in DNA and chromatin structure that accompany cell differentiation, and regulatory interactions involved in the proliferation and differentiation of normal and neoplastic hematopoietic and lymphoid cells. Laboratories in this program are now identifying the specific genes and gene products responsible for the control and arrest of cell proliferation. This has led to the isolation, characterization and purification of growth factors (the interleukins, human granulocyte-macrophage colony-stimulating factor, melanocyte growth promoting activity) which may play crucial roles in regulating the growth and/or differentiation of cells.

The regulation of cell growth and function by extracellular agents such as peptide hormones, growth factors and neurotransmitters is under investi-

gation. This involves characterization of: plasma membrane structure and function; the relationship between peptide hormone receptor structure and transmembrane signalling; structure and regulation of glycoprotein hormone gene expression; structure of intracellular receptors for steroid hormones; and the properties, functions and hormonal regulation of intracellular peptidase activities.

The genetic control of both normal and abnormal cell differentiation during embryogenesis is being characterized by analysis of an extensive set of mutations in the T/t complex of the mouse. Mechanisms leading to gene amplification and the expression of drug resistance in cultured cells are being examined. The role of homogeneously staining regions, double minute chromosomes and overproduced gene products in drug resistant cells and as related to expression of the malignant neuronal phenotype by human neuroblastoma cells is therefore being investigated. The human genome is being mapped. Other research focuses on hereditary factors in the etiology of cancer and leukemia in humans as well as the identification of individuals with inherited susceptibility to cancer through understanding mechanisms leading to the initiation and progression of neoplasia. In the area of human tumor cell biology, the protein products of cellular oncogenes are being identified and characterized. The relationship between the expression of these unique gene products and cellular transformation is now under intensive investigation.

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Unit of Developmental Therapy and Clinical Investigation

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Research Activities

The metabolism of normal and cancerous tissue *in situ* is being studied. This research program includes the innovative operation of the first isochronous

cyclotron to be used in a medical research institution, resulting in the capacity to visualize tumors as well as specific organs and tissues.

Studies of the pharmacology and pharmacokinetics of analgesic drugs in animal models and cancer patients are being carried out to provide a rational basis for the management of pain due to cancer. Pilot studies have begun on the role of serotonin in cancer associated anorexia.

Development of more selective therapeutic strategies based on differences in membrane transport and metabolic activation or inactivation of new agents *versus* normal proliferative cells continues to be the major focus of other research studies. Methods are also under study for chemical modification of antitumor enzymes to increase biological half-life, abolish immunogenicity, and alter tissue specificity. The effects of selected cytotoxic drugs and regulators of cell growth on differentiation of normal and neoplastic human hematopoietic cells are being explored.

Studies are also being carried out to determine whether or not various tumor promotors could affect the expression of previously identified cell surface antigens on normal human melanocytes or melanoma cells. Satisfactory procedures have been developed for autologous transplantation of frozen and stored hematopoietic stem cells. Also under investigation are improved methods for purging marrow of residual tumor cells and the phenotypic characterization of human leukemias and lymphomas.

Investigators have been working with flow cytometry to detect cell surface membrane light chain expression in minimal numbers of B-lymphocytes. This technique, which is called clonal excess and requires a mathematical calculation, allows the detection of less than 5 percent of malignant cells in cell suspension.

Other research objectives of this Unit are to characterize the effects of various substances on the proliferation, differentiation, and identification of biochemical substances produced by selected childhood tumors and skin tumor tissue fibroblasts.

Additional projects include the mode of action of antitumor and antiviral agents, the toxic actions of these agents in normal host tissues and mechanisms of acquired resistance of tumors and viruses to these agents. The latter studies also focus on the phenomenon of polydrug resistance. Preclinical and clinical evaluation of new analgesic, anticancer and antiviral drugs in terms of their distribution, metabolism and pharmacologic behavior are also being undertaken. These findings are correlated with observed toxic and therapeutic effects in controlled trials incorporating novel biostatistic approaches.

There are studies which seek to identify pleiotypic tumor-associated biochemical properties which might be exploited for greater antitumor selectivity. Some properties already identified as tumor-specific include certain nutrient transport mechanisms which mediate accumulation of cytotoxic drugs and DNA repair deficiencies.

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Unit of Immunobiology

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Research Activities

This program comprises the development, general properties, function and regulation of the cellular components of the immune response, as well as of the secreted products of such cells. The program's research is in three main

areas: 1) immunogenetics, especially the cell surface determinants involved in the differentiation and function of normal and malignant lymphoid cells; 2) cellular immunology and immunoregulation, especially the cellular interactions and soluble factors that are required for effective immune responses; 3) tumor immunology, particularly the analysis of the immunological properties of the transformed cancer cells and the interactions between tumor and host, aimed at designing possible diagnostic or therapeutic strategies. Research in these three main areas is done both using experimental models as well as human cells. *In vitro* technology in particular has allowed the continuous growth and cloning of most of the relevant lymphoid cells and the testing of their immunological functions. Some research projects, such as bone marrow transplantation for the correction of immunological and hematological abnormalities or the treatment of lympho-hemopoietic malignancies in patients bridge the three main areas of research, both at the clinical level and with the animal models. Since immunology is multidisciplinary in its approaches to a given problem, it not only has generated its own technology (such as the production of monoclonal antibodies) but uses the methods of other disciplines, such as biochemistry, for the isolation of a given membrane surface antigen, and molecular biology for the characterization of the gene(s) coding for such a determinant (and its own *in vitro* technology for the assessment of the function of such a determinant). The main aims of the research in the program are to define immunological events at the biological, structural, biochemical and molecular level.

The Unit offers the opportunity for obtaining a Ph.D. degree with emphasis on various sub-diciplines of immunology such as immunochemistry, immunogenetics, immunopathology, serology, transplantation immunology, tumor immunology, and clinical immunology.

Recent Publications

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Unit of Molecular Biology and Virology

Faculty

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Erwin Fleissner
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Jeffrey V. Ravetch
Ora M. Rosen
Barbara H. Rosenberg
Nural H. Sarkar
Ganes C. Sen
Michael Sheffery
Edward Stavnezer
Janet Stavnezer

Research Activities

The major areas of research training in this Unit are in cellular and viral gene expression, DNA replication, control mechanisms in cellular metabolism and growth, and the molecular basis of oncogenesis. Investigators utilize modern biochemical and molecular genetic methods in experimental systems ranging

from prokaryotes and simple eukaryotes to transgenic mice and human tumor cells.

The control of gene expression is studied in a variety of viral and cellular systems, *in vitro*, in cell culture, and in the intact organism. Influenza virus and adenovirus serve as models for the control mechanisms involved in the synthesis, processing and translation of RNA, both in the cell and in cell-free systems. Various eukaryotic virus expression vectors are being constructed for these studies. Virus-infected cells are also being employed for molecular studies of interferon action. Cells responsive to specific inducing agents are used to elucidate the regulation of gene transcription by peptide hormones, by interferon, and by chromatin structure. The gene amplification or rearrangement events frequently observed in tumor cells reveal the profound effects of such DNA alterations on gene transcription. Mice carrying new genes introduced by injection of DNA into early embryos provide novel examples of tissue-specific control of gene expression.

Research on the mechanism of both prokaryotic and eukaryotic DNA replication employs cell-free replication systems. Cell-free synthesis of adenovirus DNA is being employed as the model system to elucidate control elements and specific protein-nucleic acid interactions involved in eukaryotic DNA replication.

Much of the research on the control of cellular metabolism and growth focuses on crucial regulatory proteins involved in the transmission of signals at the cell membrane, including various cell surface receptors, protein kinases, and the calcium binding protein calmodulin. In addition to biochemical and physiological studies, substantial effort is being made to isolate and determine the nucleotide sequences of the genes encoding these important proteins.

A large area of research centers on viral and cellular genes directly implicated in neoplasia. Studies have shown that retroviruses in birds, rodents, and cats transduce a number of oncogenes encoding proteins that vary greatly in their cellular localization, biochemical function, and mechanism of activation. Other retroviruses do not carry oncogenes, but alter the expression of cellular oncogenes, leading to the development of specific cancers, such as lymphomas, thymomas and erythroleukemia. Activated oncogenes have also been identified in the DNA of animal and human tumors with no known viral etiology. The study of the mechanism of activation of these cellular genes and of their gene products may provide insight into the molecular basis of human cancer.

Recent Publications

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Requirements and Course Offerings

Admission

Applications

For admission to the Graduate School of Medical Sciences an applicant must (1) have a baccalaureate degree or the equivalent from a college or university of recognized standing, (2) have adequate preparation in the chosen field of study, and (3) show promise of ability to pursue advanced study and research, as judged by his or her previous record.

Inquiries about graduate study should be addressed to the Associate Dean of the Graduate School of Medical Sciences, 1300 York Avenue, New York, NY 10021 or to the Associate Director of the Sloan-Kettering Division, 1275 York Avenue, New York, NY 10021.

Candidates may be admitted in September, February, or July, although places in the graduate program for February and July may not be available because of prior commitments to applicants for September admission. Applicants for February or July admission should correspond directly with the respective Field Director in the Medical College Division or the Associate Director of the Sloan-Kettering Division regarding the availability of places.

Application material must be completed and returned to the Office of the Dean together with (1) official transcripts of records from all colleges and universities attended, (2) a statement of purpose of graduate study, and (3) two letters of recommendation from individuals in academic positions who know the applicant professionally. In addition, scores from the Graduate Record Examinations are usually required to aid in the evaluation of an applicant. Application for taking the Graduate Record Examinations (GRE's), the Aptitude (Verbal, Quantitative, and Analytical) Test and the Advanced Test, must be made directly to the

Educational Testing Service
Graduate Record Examinations
Box 955
Princeton, NJ 08541

The proper Institution Code Number to use in your GRE application for the Cornell University Graduate School of Medical Sciences (New York City) is R 2119-6.

Applications for September or July admission and all credentials, including official transcripts of records from all colleges and universities attended, must be received by the deadline date of February 1.

Applications and credentials for February admission must be received by November 1.

Application fee. A nonrefundable charge of $25 is made for filing an application for admission.

The completed application and all supporting documents are reviewed by

by the Division Credentials Committee. Applicants who are considered potentially acceptable are usually called for a personal interview. At the time of interview, after discussing his or her interests with the members of the Field or Unit, the applicant may tentatively select a major sponsor. If accepted by the Field or Unit, an application is returned to the Dean who may refer it to the Executive Committee for final review and decision. A student is formally notified of acceptance for study in the Graduate School of Medical Sciences by a letter from the Dean. An applicant accepted for admission is requested to inform the Graduate School of Medical Sciences of her or his plan to either accept or refuse the offer of admission within one month after the Dean's acceptance letter has been received.

It is the policy of Cornell University to actively support equality of educational and employment opportunity. No person shall be denied admission to any educational program or activity or be denied employment on the basis of any legally prohibited discrimination involving, but not limited to, such factors as race, color, creed, religion, national or ethnic origin, sex, age, or handicap. The University is committed to the maintenance of affirmative action programs which will assure the continuation of such equality of opportunity.

Admission policies are also in conformity with the policy of New York State in regard to the American ideal of equality of opportunity as embodied in the Education Practices Act.

Categories

An applicant is accepted by the Graduate School of Medical Sciences (1) as a degree candidate for the M.S. or Ph.D., or (2) as a provisional candidate.

Provisional candidacy provides opportunity for a prospective degree candidate, whose educational preparation is difficult to evaluate, to begin graduate studies. On the basis of the record of accomplishment in the first half of the academic year, the adviser or temporary Special Committee of a provisional candidate may recommend to the Dean that (1) provisional candidacy be changed to degree candidacy, (2) provisional candidacy be continued for the remainder of the academic year, or (3) provisional candidacy be terminated. A maximum of one academic year in the status of provisional candidacy is permitted and credit of a maximum of one residence unit may be allowed on petition, provided there is convincing evidence that performance has been of the same quality as that required of degree candidates.

Special Students

Special students are students who are not degree candidates in either the Graduate School of Medical Sciences or the Medical College and who are given permission by the respective dean to take courses at either school. Special students must be degree candidates at other institutions and the courses taken at

Cornell must be essential to their degree programs and are not offered by the institutions at which they are matriculated as degree candidates as certified by the institutions. Enrollment as a special student is not intended as preparation for admission to degree programs at Cornell or elsewhere.

In the case of the Graduate School of Medical Sciences, special students are accepted only with the approval of the appropriate Field Director in the Medical College Divission or of the appropriate Chairperson in the Sloan-Kettering Division. Special students must demonstrate special qualifications in terms of preparation and ability. They must register with the appropriate office in the Graduate School of Medical Sciences or in the Medical College and must pay all tuition and fees before being permitted to attend lectures or laboratory sessions. Tuition is computed on the basis of the ratio of course hours taken to the total hours of instruction for the academic year (33 weeks of 40 hours). There is a registration fee of $25.

Degree Requirements

Major and Minor Fields*

A candidate for the degree of Master of Science is required to register for study in one major and one minor field. Each field decides whether the Special Committee of a candidate for the Ph.D. degree must have two or three fields represented. Accordingly, a candidate for the degree of Doctor of Philosophy is required to register for study in one major and one or two minor fields. At least one of the minors must be outside the area of the major field.

The Special Committee

The general degree requirements of the Graduate School of Medical Sciences are minimal in order to give maximum flexibility in choosing a desirable program of study. The student's program is determined with the aid and direction of a Special Committee, consisting of at least three faculty members chosen by the student from those fields that best fit his or her areas of interest. Satisfactory progress toward a degree is judged by the committee rather than by arbitrary standards imposed by the Graduate School of Medical Sciences. There are no regulations of the Faculty of the Graduate School of Medical Sciences governing the specific content of instruction, courses, or grades to which the Special Committee must subscribe, except those imposed by the fields. The committee is primarily responsible for the candidate's development as an independent scholar and scientist.

*Areas of concentration towards a degree at the Cornell University Graduate School of Medical Sciences are referred to as *Fields* in the Medical College Division and as *Units* in the Sloan-Kettering Division. Both these terms are intended to be covered by the term *field* in this and subsequent sections.

No later than four weeks after enrollment, a candidate must file a statement of the major and minor fields elected for study, after which the student must choose faculty members to represent the fields and to serve on a Special Committee. The faculty member representing the major field usually advises the student concerning the other selections and chairs the committee. At least one member of the committee must represent a field different from the candidate's major field. Members may agree to serve temporarily during the candidate's first year of residence until the candidate has had the opportunity to become acquainted with areas of research in the fields of his or her choice. On completion of this year of residence, a permanent Special Committee will be formed, the membership of which can be changed with agreement of all members of the old and newly formed committees and the approval of the Dean. The members of the Special Committee decide on the student's program of study and research, and judge whether progress toward a degree is satisfactory. After consulting the other members, the chairperson of the Special Committee prepares term reports on the candidate for submission to the Dean. The members of the committee serve on all the candidate's examining committees and they approve his or her thesis.

Registration and Course Grades

No student in the Graduate School of Medical Sciences may double-register for an advanced general or professional degree with any other school or college except the Cornell University Medical College.

At the beginning of each term, students are required to register with the Office of the Graduate School of Medical Sciences and to file a registration of courses form indicating all courses they will take. A fee of $10 is charged for late registration.

At the beginning of each course in which the student is enrolling, the student will complete a separate course registration form for the instructor. All courses for which the student registers for credit will be entered in the official record. Grades of graduate students are reported as: Excellent (E), Satisfactory (S), Unsatisfactory (U), Incomplete (I), Absent (Abs.), or Unofficially Withdrawn (W). A grade of Incomplete or Absent cannot be changed later than one term following the one in which the course was taken.

Registration for the summer is required of graduate students who will be engaged in research.

Residence

The Faculty of the Graduate School of Medical Sciences regards study in residence as essential. Each candidate for an advanced general degree is expected to complete the residence requirements with reasonable continuity. A student must register each term from the time of his or her first registration in the

Graduate School of Medical Sciences until the student either withdraws or completes a degree (unless a leave of absence has been granted). Full-time study for one-half academic year with satisfactory accomplishment constitutes one residence unit. Two units of residence are the minimal requirement for the master's degree and six units are the minimum for the doctoral degree. However, the time necessary to obtain the degree generally exceeds the minimal requirements. A candidate for the Ph.D. degree must spend two of the last four units of required residence in successive terms on the New York City or the Ithaca campus of Cornell University. No more than seven years may intervene between the time of first registration and the completion of all requirements for the doctoral degree. A student must complete all requirements for the master's degree in four years.

Part-time graduate study, if it is necessitated by off-campus employment noncontributory to the major field of study, is not encouraged. Requests for part-time study must be reviewed by the Executive Committee. If permission is granted for part-time study, the student must be in residence at least half-time.

The legislation with respect to eligibility of part-time students for residence units is as follows:

Employment	Residence Units Allowable Per Half Academic Year		
Total clock hours per week	*Contributory in major field; on campus*	*Noncontributory; on campus*	*Off Campus*
0–10 hours	1 unit	1 unit	¾ unit
11–20 hours	1 unit	¾ unit	¾ unit
21–30 hours	¾ unit (teaching) ¾–1 unit (research)*	½ unit	—

*Time spent assisting in research, if it is contributory to the major field of study, shall be credited toward allowance of a full residence unit.

Transfer of Residence Credit

No residence credit will be granted for study outside the Graduate School of Medical Sciences to fulfill the requirements of the M.S. degree. No commitment can be made about granting residence credit toward the Ph.D. requirements for previous study in another graduate school until after the candidate has entered into residence at the Graduate School of Medical Sciences. At that time, the student's Special Committee may recommend acceptance of study outside the Graduate School of Medical Sciences to the Executive Committee, which will determine the number of residence units to be awarded. No credit can be transferred for study undertaken as an undergraduate or as a special

student even in courses designed for graduate students.

A student who has satisfactorily completed two or more academic years of study toward the degree of M.D. at the Cornell University Medical College, or another accredited medical school in the United States with a curriculum equivalent to that of the Cornell University Medical College, may transfer a maximum of two units of residence credit after passing an evaluation examination administered by a committee appointed by the Executive Committee of the Graduate School of Medical Sciences.

Summer Research

Registration is required for the summer research term whether or not this effort will be credited toward residence unit accumulation. Students registered for summer research pay prorated tuition only if they are obtaining residence credit. However, no degree candidate is eligible for more than two residence units in any period of twelve consecutive months.

Study *In Absentia*

A candidate for the degree of Doctor of Philosophy may petition for permission to earn residence units for study away from Cornell University while regularly registered in the Graduate School of Medical Sciences. A candidate to whom this privilege has been granted, must register as a Candidate *in absentia* and may work temporarily under the immediate supervision of an individual designated by his or her Special Committee although the candidate's program will continue to be directed by the Committee. For study *in absentia*, not more than two residence units may be earned toward fulfillment of the minimal residence requirements for the Ph.D. degree.

Leave of Absence

A candidate who finds it necessary to interrupt the continuity of his or her residence must petition the Dean for an official leave of absence. This written petition must specify the term of absence, state the reason for the requested leave of absence, and be approved by the student's Special Committee.

A student who will *not* be in residence but will return to the Graduate School of Medical Sciences to present and defend a thesis at the final examination, having completed all requirements for a degree except for the final examination, *must* petition for a leave of absence.

Examinations

Three examinations are required by the Faculty of the Graduate School of Medical Sciences: (1) Final Examination for the M.S. degree, (2) Examination for Admission to Doctoral Candidacy, and (3) Final Examination for the Ph.D.

degree. Examinations are administered by an Examining Committee consisting of a chairperson appointed by the Dean, the members of the candidate's Special Committee, and, in the case of the Admission to Doctoral Candidacy Examination, three additional members selected from the Faculty of the Graduate School of Medical Sciences and/or of other institutions. In addition to these examinations, the candidate's major field may require a qualifying examination as part of its evaluation of the candidate after two units of residence have been completed.

For the M.S. degree: The Final Examination may be oral or both oral and written.

For the Ph.D. degree: The Admission to Doctoral Candidacy Examination is both oral and written and certifies that the student is eligible to present a thesis to the Faculty of the Graduate School of Medical Sciences. The examination should be taken after course work is largely finished but before significant thesis research has begun. Accordingly, the usual examination time will be at the end of the second year of residence. The examination may not be taken until two units of residence credit have been accumulated and a minimum of two units of residence credit is required after passing this examination before the final examination can be scheduled. The final examination for the Ph.D. degree is an oral defense of the candidate's thesis. It must be passed within four years after completion of the required residence units, or within seven years from the date of first registration, whichever is earlier.

Foreign Language Requirements

Each field of study has its own foreign language requirements. The student's Special Committee may require knowledge of foreign languages beyond the requirements of the fields listed in this *Announcement*.

Arrangements for a foreign language examination will be made on application to the Office of the Dean. As an alternative to this examination, the candidate may demonstrate proficiency by having passed the reading part of the language qualification tests administered by the College Entrance Examination Board.

Thesis

A principal requirement for both the M.S. and the Ph.D. degrees is the presentation of a thesis constituting an imaginative contribution to knowledge. Ordinarily, the thesis is written on a research topic in the candidate's major field of study, under the direction of the chairperson of his or her Special Committee. The faculty requires that the Ph.D. thesis be published in abstract and be recorded on microfilm.

Tuition and Fees

Tuition

Tuition for a student regularly matriculated in the Graduate School of Medical Sciences is $9,600 for the academic year 1984–85 and is payable in two equal parts, the first of which is due at initial registration. Tuition includes fees for matriculation, hospitalization insurance, graduation, and miscellaneous thesis expenses.

For students who (1) have been in continuous residence at Cornell in the same doctoral program and have accumulated four units of residence credit, (2) have passed their Admission to Doctoral Candidacy Examination, and (3) are not taking courses in the Medical College curriculum, a reduced charge of $1800 per annum ($900 per semester) will be made for tuition and fees for the terms subsequent to the Admission to Doctoral Candidacy Examination. For those students who are accepted in the Ph.D.–M.D. Program (see p. 69) and will continue to take courses in the medical curriculum, an additional tuition charge, based on the Medical College tuition ($13,660 per annum), will be made for the medical course hours taken.

A student who is to receive partial residence credit (see p. 61) because of employment should apply for proration of tuition on forms obtainable at the Office of the Dean. Proration of tuition does not apply to the special reduced tuition of $900 per semester.

Other Fees

In Absentia A student registered *in absentia* pays a fee of $200 each term and may continue hospitalization insurance by payment of the annual premium directly to the Student Accounting Office. If students *in absentia* take advantage of local privileges, such as the use of the library, desk space, Student Health Service, and Cornell housing, the fee is $400 per semester. The latter fee also covers hospitalization insurance.

Leave of Absence Students on leave of absence will be required to pay an active-file fee of $200 for each semester, up to a maximum of six semesters, during which they are not registered with the Graduate School. This fee will not be subject to finance charges but must be paid before the student can receive an advanced degree. Petition for waiver of this fee will be considered for students who have not completed the required number of residence units.

Candidate for Degree Only A graduate student who has previously fulfilled all other degree requirements, who has been granted a leave of absence, and who returns to the Graduate School of Medical Sciences to present a thesis and to take the final examination must register as a Candidate for Degree Only.

Any individual who owes money to the University will not be allowed to register or reregister in the University, receive a transcript of his or her record, have his or her academic credits certified, be granted a leave of absence, or have a degree conferred.

The amount, time, and manner of payment of tuition, fees, or other charges may be changed at any time without notice.

Refunds

Part of the amount *personally* paid for tuition will be refunded if the student obtains official certification of leave of absence or withdrawal from the Graduate School of Medical Sciences during the semester. Students who terminate their registration during a regular term in this manner will be charged tuition from the registration day to the effective date of the certificate as follows: first week, 10 percent; second week, 20 percent; third week, 30 percent; fourth week, 40 percent; fifth week, 60 percent; sixth week, 80 percent; seventh week, 100 percent. No charge will be made if the effective date of leave or withdrawal is within the first six days of the term, including registration day.

Financial Assistance

All applicants to the Graduate School are requested to submit a Graduate and Professional School Financial Aid Service (GAPSFAS) form providing an estimate of financial need. The information will be used in two ways: The number of students with documentable need will allow the University to obtain maximum federal funding for loans and work-study purposes, and the specific need of an applicant *may* be used to determine that individual's graduate support. Please obtain the necessary form, available at your college or university financial aid office and from the Educational Testing Service. File the form with the Educational Testing Service, Box 2614, Princeton, New Jersey 08541, and request that the information be sent to Cornell–Code 2267.

Financial assistance is available to qualified applicants. Individual fields may offer predoctoral research fellowships, research assistantships, or teaching assistantships. These positions may provide a stipend in addition to tuition. Information about these positions may be obtained directly from the Field or Unit at the time of application.

Nationwide competitive predoctoral fellowships are available from the National Science Foundation and the National Research Council. Information about these fellowships should be requested directly from the appropriate governmental agency.

New York State residents are eligible for several predoctoral fellowships and the Tuition Assistance Program, which assists in tuition payments. Appli-

cation forms may be obtained from the New York Higher Education Services Corporation, Student Financial Aid Section, Tower Building, Empire State Plaza, Albany, NY 12255.

Several loan programs are available to graduate students. Under these programs, repayment of the principal amount of the loan together with the interest on the loan may be deferred until after graduation. Complete information regarding loan programs may be obtained from the Graduate School Office.

Opportunity for part-time employment is often available in departmental research projects or other activities. Applications should be made directly to individual departments.

The Graduate School of Medical Sciences participates in the Work-Study Program of Cornell University. For the 1984–85 academic year, the maximum contribution to a student's salary is $2,800.

Scholarships and Fellowships

Full fellowships are provided for graduate students by both the Medical College and Sloan-Kettering Divisions of the Graduate School of Medical Sciences. Recipients of this award become Ph.D. Fellows and will receive a full tuition scholarship and a stipend covering living expenses.

In addition, a number of tuition scholarships are available for students in the Medical College Division who are not covered by one of the above fellowships. This scholarship fund is administered by the Office of the Dean of the Graduate School of Medical Sciences.

The Vincent Astor Scholarship Fund. Funds for limited tuition assistance are also derived from the income from a generous gift by the Vincent Astor Foundation to the Graduate School of Medical Sciences and to the Medical College. Allocation of these funds for graduate student tuition assistance is made at the discretion of the Dean of the Graduate School of Medical Sciences on the recommendations of the Field Directors in the Medical College Division and of the Associate Director of the Sloan-Kettering Division.

The Frank R. and Blanche A. Mowrer Memorial Fund. Limited financial assistance is available from the income of this fund to one student per year enrolled in the Ph.D.–M.D. or M.D.–Ph.D. program.

Awards and Prizes

The Frank Lappin Horsfall Jr. Award is endowed by funds provided in memory of Dr. Horsfall by his many friends and family. It is continued evidence of his concern for students manifest during his directorship of the Sloan-.

Kettering Division.

The award is made annually to a student of the Sloan-Kettering Division, who in the opinion of the Committee of the Faculty of the Sloan-Kettering Division, has been most distinguished, especially in the Admission to Doctoral Candidacy Examination.

Recipient of the award in 1984 was Janet Braam.

The Julian R. Rachele Prize. The income of a fund established by Dr. Julian R. Rachele, former Dean of the Cornell University Graduate School of Medical Sciences, provides for an annual prize to be awarded to a candidate for the Ph.D. degree for a research paper of which the candidate is the sole or the senior author. This paper must have been accepted during the twelve-month period ending 30 April for publication in a scientific journal representing one of the fields of the Graduate School of Medical Sciences. In order to qualify for the prize, a student must have passed the Admission to Doctoral Candidacy Examination.

A candidate for the prize must submit a copy of the manuscript to the Dean by 30 April for evaluation by an ad hoc committee appointed by the Dean. Manuscripts received after 30 April will be considered for the award in the subsequent year.

Recipient of the prize in 1984 was Susan M. Fitzpatrick.

Student Health Services

The Student Health Plan of Cornell University Medical College provides hospitalization and major medical insurance for all registered graduated students. In addition, the Plan provides for ambulatory care at the Personnel Health Service of The New York Hospital-Cornell Medical Center. Physicians at the Health Service will refer students who require specialized care to clinics of the Hospital and to attending physicians of the staff.

The cost of medical services provided by the Plan are included in the tuition and fee structure announced by the Graduate School of Medical Sciences each academic year. Students will be issued Plan membership cards and will receive courtesy privileges at The New York Hospital Pharmacy.

Entering students are requested to have a physical examination, chest X-ray and laboratory tests performed by their personal physicians prior to matriculation. The hours of the Personnel Health Service and a complete statement of Plan benefits will be provided to each graduate student.

It is recommended that students purchase insurance coverage for eligible dependents who do not have other insurance available to them. Insured dependents are not eligible for care at the Personnel Health Service but they will be referred to appropriate members of the Hospital staff for medical treatment.

A student studying *in absentia* may continue hospitalization insurance by

payment of the annual fees directly to the Student Accounting Office.

A student on leave of absence is not eligible to receive student health benefits.

Residence Halls

F. W. Olin Hall, a student residence, is at 445 East Sixty-ninth Street directly across from the Medical College entrance on York Avenue. Olin Hall contains a gymnasium, lounges, and 245 residence rooms. Each residence room is furnished as a single bedroom-study, but since two rooms share a connecting bath, they may be used as a suite for two students. The rooms are completely furnished. The student housing fee is $1,750 for the 10-month academic year, $2,100 for the calendar year, or $175 per month for shorter periods.

Livingston Farrand Apartments, also located on East Sixty-ninth Street, just beyond Olin Hall, have furnished apartments of 1½, 2, 3, and 4 rooms. Cooking facilities are provided in these apartments. Housing fees range from $222–$414 per month (utilities not included). Apartments in these facilities are available to married and upper-class students.

Jacob S. Lasdon House, an apartment residence, is located at 420 East Seventieth Street. This building contains studio, one-bedroom, and two-bedrooom apartments and two squash courts. Apartments are fully furnished, and housing fees range from $380–$690 per month including utilities. Single, first-year students cannot be accommodated in this building.

The fees listed above may be changed at any time without previous notice.

Special Programs

Application to the Medical Scientist Training Program (M.D.–Ph.D.)

Successful applicants must demonstrate a strong undergraduate science preparation, and an early commitment to a career combining both clinical and laboratory research. They must simultaneously satisfy the separate requirements for admission to Cornell University Medical College and to the Divisions of the Graduate School of Medical Sciences.

Applications must show whether admission is sought to the M.D.–Ph.D. program of the Medical College Division, the Sloan-Kettering Division, or both (see p. 4 for a description of the programs). Only one set of documents is required for applications to either or both programs. All documents must be forwarded to the *Office of Admissions, Cornell University Medical College, 445 East 69th Street, New York, NY 10021.* (Telephone 212, 472-5673).

The following items are required, by November 30, for an application to be considered complete:

1. AMCAS application. (The personal data and academic record presented in this application are suitable for evaluation by both the medical and graduate schools.)
2. MCAT scores; GRE scores, if available.
3. A personal statement summarizing the applicant's background, interests, and reasons for pursuing the combined program.
4. Evaluation by the pre-medical advisory committee or two letters from members of the undergraduate science faculty addressing themselves to the applicant's suitability for a career in medicine.
5. Evaluations by at least two faculty members addressing themselves to the applicant's research potential.
6. A check for $45 to cover the application fee, made out to "Cornell University Medical College."

After screening, selected applicants to the program will be invited to visit the Cornell Medical Center and meet with members of the faculty of the medical and graduate programs. These interview visits will be coordinated by the Medical College Admissions Office.

Application to the Ph.D.–M.D. Program

Applications to this program (see p. 4 for description) are ordinarily made after the completion of the first year of study in the Graduate School of Medical Sciences, although more advanced students may be considered. The deadline for application is February 1.

To apply, the student must submit to the Office of the Dean of the Graduate School of Medical Sciences:

1. A completed application for admission with advanced standing to Cornell University Medical College (obtainable from the Medical College Admissions Office).
2. A plan of graduate study incorporating all required course work of the first two years of the Medical College curriculum and endorsed by the student's Special Committee.
3. Evidence of successful completion of at least two major medical school basic science courses (anatomical sciences, biochemistry, microbiology, pathology, pharmacology, physiology).
4. Two letters of evaluation from faculty of the Graduate School of Medical Sciences.

The Office of the Dean of Graduate School of Medical Sciences will review the student's credentials and make a recommendation to the Committee on Admissions of Cornell University Medical College. Only applicants who are

found to be acceptable by this committee, after review of the application and personal interviews, can enter the Ph.D.–M.D. Program. Final decisions will be made before June 1.

Students in this program must meet the following requirements before admission to the third-year clinical curriculum of the Medical College:

1. Complete all required graduate courses and the remainder of the first two years of the medical school curriculum.
2. Pass the Admission to Doctoral Candidacy Examination, required by the Graduate School of Medical Sciences.
3. Complete the dissertation research; present and successfully defend an original thesis at the final examination for the Ph.D. degree

After satisfactory fulfillment of the required clinical rotations of the Cornell third-year medical school curriculum, these students may receive credit for their graduate studies to satisfy the elective requirements of the fourth-year medical school curriculum and will then be recommended for award of the M.D. degree by Cornell University.

While registered as a graduate student in the Ph.D.–M.D. Program, the student is subject to the tuition schedule of the Graduate School of Medical Sciences. Upon completion of the requirements for the Ph.D. degree, the student is registered in the Medical College and is subject to its tuition schedule.

Instruction at the Medical College Division

Field of Biochemistry

Field Director

A. Meister, Department of Biochemistry, Room E-106, Medical College, (212) 472-6212

Faculty Representative

D. Wellner, Department of Biochemistry, Room E-219, Medical College, (212) 472-6197

Graduate instruction is offered leading the the Ph.D. degree. Within the framework of degree requirements and in consultation with the student, the course of study is planned to fit the need of the individual. Although formal course work is required, emphasis is placed on research. Research opportunities exist in various areas of biochemistry including enzymology, structure and function of proteins and nucleic acids, molecular biology, physical biochemistry, and the intermediary metabolism of amino acids, carbohydrates, nucleic acids, and lipids. Entering graduate students usually work for short periods in several of the laboratories of the faculty members of the Field before beginning their thesis research. Students are encouraged to choose challenging fundamental research problems that are on the frontiers of biochemistry.

The laboratories of the faculty members are equipped with virtually all of the instruments and facilities required for modern biochemical research; thus, graduate students are instructed in such methodology as chromatography, countercurrent distribution, radioactive and stable isotope techniques, spectrophotometry, electrophoresis, and analytical ultracentrifugation.

Students who undertake graduate study in biochemistry must have a sufficiently comprehensive background in chemistry to pursue the proposed course of study and must present evidence of knowledge of biology, general experimental physics, mathematics (including differential and integral calculus). Students may remedy deficiencies in these areas during the first year of graduate study. The Graduate Record Examinations (the Aptitude Test and the Advanced Test in chemistry) are ordinarily required.

The student is required to demonstrate proficiency in one modern foreign language acceptable to the student's Special Committee. Proficiency in a computer programming language, as demonstrated by executing a meaningful program, may substitute for proficiency in a foreign language.

Courses

Graduate Biochemistry Offered jointly by the faculties of the Medical College and Sloan-Kettering Divisions. This course is designed to provide the student with a knowledge of the fundamentals of biochemistry and an appreciation of the molecular basis of biological phenomenia. Graduate students in the Field of Biochemistry are required to pass this course (or its equivalent). First and second trimesters. Drs. Haschemeyer and Lloyd.

Advanced Biochemistry This course consists of one or more lecture series (minicourses) covering selected areas of current interest at an advanced level. The topics change from year to year and may be repeated after 2 or 3 years. The subjects offered include: 1) nucleic acids and protein synthesis; 2) intermediate metabolism and its regulation; 3) kinetics and enzyme mechanisms; 4) protein and peptide microchemistry; 5) membrane structure and function; 6) hormones; 7) computer programming for the biochemist; 8) physical methods in the study of macromolecular and cellular structure; 9) design of inhibitors of enzymes and transport systems. Prerequisite: Graduate Biochemistry. See below for courses offered in 1984–85.

Membrane Biochemistry Third trimester. Dr. Hajjar.

Protein and Peptide Microchemistry Third trimester. Dr. Udenfriend.

Design of Inhibitors of Enzymes and Transport Systems First, second, and third trimesters. Dr. Griffith.

Other Academic Offerings

Introduction to Research Experimental biochemistry dealing with the isolation, synthesis, and analysis of substances of biochemical importance (enzymes, coenzymes, various metabolites and intermediates), and study of their properties by various chemical and physical techniques. The student obtains this varied research experience by spending approximately two months in the laboratory of each of four faculty members of his or her choice. For incoming graduate students majoring in biochemistry.

Biochemistry Seminars A seminar series in which students, faculty, and invited scientists from this and other institutions present on progress in their laboratories.

Field of Cell Biology and Genetics

Field Director

D.A. Fischman, Department of Cell Biology and Anatomy, Room E-116, Medical College, (212) 472-6400

Faculty Representative

J.L. German III, New York Blood Center, 310 E. 67 St., New York, NY 10021, (212) 570-3075

The Field of Cell Biology and Genetics offers a program of advanced study leading to the Ph.D. degree. The program is intended to prepare students for a career in basic research and teaching in cell, developmental and molecular biology, genetics, anatomical sciences, or related health sciences. Administration of the Field is based in the Department of Cell Biology and Anatomy in a recently renovated research wing of Cornell University Medical College. Additional laboratories are located in various departments of Cornell University Medical College, the Sloan-Kettering Institute, and the New York Blood Center.

For graduate study in the Field, adequate undergraduate preparation in biology, chemistry (including organic chemistry), physics, and mathematics is recommended. Requirements for admission are flexible in proportion to the promise and accomplishments of the applicant. Applicants are requested to present results of the Graduate Record Examinations.

Requirements for minor sponsorship in the Field will be arranged with individual students, but research experience in the minor sponsor's laboratory is strongly encouraged.

Students are generally required to take Cell Biology and Microscopic Anatomy and at least three of the more advanced courses in genetics, molecular biology, cell biology, or developmental biology.

In addition to the courses listed below, appropriate courses for graduate students in the Field are Biochemistry, Physiology and Biophysics, and those courses given by the Field of Neurobiology and Behavior.

Students are expected during their first year to spend time and perform experiments in the laboratories of three faculty members of the Field.

A reading knowledge of a foreign language is desirable.

The Field requires a qualifying examination at the end of the first year of residence. At the discretion of the examining committee, the examination may be written, or oral, or both. The Admission to DoctoralCandidacy Examination required by the Graduate School of Medical Sciences must be taken before six units of residence credit have been accumulated and before substantial progress has been made in the candidate's thesis research.

Courses

Cell Biology and Microscopic Anatomy Offered by the Staff of the Field of Cell Biology and Genetics, Medical College Division, in conjunction with the Department of Cell Biology and Anatomy, Medical College. This course follows a cellular and differentiative approach aimed at understanding the structure-function correlates that characterize the different tissues and organs. Selected topics are presented in the lectures and laboratory exercises to indicate a pattern of study and depth of analysis that the student can be expected to apply to the study of cells and tissues. A microscope slide collection, presenting tissues and organs in a variety of physiological and developmental states, as well as correlative electron micrographs are provided for individual study in the laboratory. Students must provide their own compound microscopes through their departments or sponsors. First and second trimesters.

A required component of the course for all graduate students is a 2 hour, weekly seminar (time to be arranged) focussing on detailed analysis of original literature, pertinent methods and unresolved questions related to topics in cell and developmental biology. The staff.

Gross Anatomy Regional anatomy is studied principally through dissection of the human body. Supplementing this technique are prosections by instructors, tutorial group discussions, and radiographic and endoscopic demonstrations. Enrollment is limited and students should consult the staff early in order to determine the availability of places. First and second trimesters. The staff.

Topics in Molecular Genetics The class will focus on key topics of molecular biology concerning gene structure and organization in prokaryotes and eukaryotes, chromosome structure, DNA replication, protein synthesis, and translational and transcriptional control. The use of genetic, biochemical, and molecular biological methods to study the questions experimentally will be covered in depth. Some topics of current interest such as immune diversity, oncogenes, and development will also be covered. The course will include an equal number of lectures and group discussions of representative research papers. Prerequisite: background in biological sciences. Limited to 20 students. Second trimester. Drs. Chao and Traktman.

Advanced Cell Biology Advanced course in cell biology with emphasis on the analysis of original literature. The course is aimed at a research level and would be of interest for students planning a career in academic medicine. Prerequisites: passing grade in Cell Biology and Microscopic Anatomy. Limited to 10 students. Third trimester. Dr. Fischman.

Developmental Biology Principles of descriptive, experimental, and molecular developmental biology will be presented, using several animal systems as examples. Early development of the whole organism, and of cells, tissues, and organs will be considered. Prerequisites: microscopic anatomy, biochemistry.

Limited to 15 students. Third trimester. Drs. Bachvarova and Bader.

Genetics Designed to give the student a sound background in genetic theory and an in-depth consideration of the gene as a unit of heredity. Second trimester 1985–86. Drs. Bennett and Graf.

Karyotyping Practical experience in chromosome analysis in the laboratory. Limited to 2 students. Third trimester. Dr. German.

Practicum in Electron Microscopy A workshop in practical aspects of electron microscopy. Following a weekly one hour lecture, students will conduct specific protocols involved in electron microscopy. Topics to be covered include: tissue fixation, embedding and thin sectioning; transmission and scanning electron microscopy; shadow-casting of proteins and nucleic acids; immunocytochemistry; photography. All participants will be required to complete an independent project. Prerequisite: consent of instructors. Requirements for passing grade: completion of an independent project paper. Limited to 6 students. Offered every year. Not offered in 1984–85. Mr. Dennis and staff.

Field of Microbiology

Field Director

K.I. Berns, Department of Microbiology, Room B-202, Medical College, (212) 472-6540

Faculty Representative

R.W. Dickerman, Department of Microbiology, Room B-204, Medical College, (212) 472-6189

The Field of Microbiology offers graduate training leading to the Ph.D. degree. Under special circumstances, candidacy towards the M.S. degree will be considered. Candidates may select an area of research from such microbiological topics as general and medical bacteriology, microbial chemistry and physiology, immunology and virology, and parasitology.

Prospective students should complete at the undergraduate level a minimum of one year (or its equivalent) in general chemistry, organic chemistry, general physics, mathematics (including college algebra), botany or zoology (preferably both), and one semester or its equivalent of analytical or quantitative chemistry. General microbiology or bacteriology and calculus are strongly recommended. Students who have not completed the above requirements may be admitted to graduate study on the condition that deficiencies be corrected soon after admission. Applicants are ordinarily required to present Graduate Record Examinations scores for the Aptitude Tests and for the Advanced Test in chemistry or biology.

Individual programs are determined by the student's Special Committee, composed of faculty members representing the major and minor fields. Students majoring in microbiology select their primary courses from those listed below. The nature and number of other courses that may be taken at this institution or at nearby universities will depend on the students' minor fields, their research activities, their individual interests, and the advice of the Special Committees. All students majoring in microbiology are required to assist in the teaching of courses offered by the Field.

Students majoring in other fields who elect to minor in microbiology are ordinarily required to take the course Microbiology and an Introduction to Infectious Disease. In addition, students are required to enroll in an advanced course in microbiology or participate in a research project in the laboratory of their minor sponsors. In general this research is expected to take one to three months to complete, depending upon whether the project is pursued on a full-time or part-time basis.

Although a qualifying examination is generally not given, a student's Special Committee has the prerogative of requiring it. The Admission to Doctoral Candidacy Examination must be taken by all Ph.D. candidates. The written portion of this examination tests for basic facts and concepts in the candidate's area of study and for the candidate's problem-solving ability within and across disciplinary boundaries. The oral examination provides an opportunity for the student to correct deficiencies in the written examination, to be examined further on general knowledge, and to discuss and be questioned on his or her planned or current research.

Courses

Microbiology and an Introduction to Infectious Disease Consists of laboratory exercises, lectures, and group discussions. The laboratory work includes an introduction to the procedures used in studying microorganisms, exercises on various physical and biological manifestations of antigen-antibody reactions, the actions of chemotherapeutic agents, a survey of the microbial flora of the upper respiratory and lower intestinal tracts of healthy humans, and an intensive study of the causal agents of specific infections, including fungi, spirochetes, rickettsiae, and viruses, as well as bacteria. The lectures are directed toward the development of basic concepts, particularly the principles involved in microbial growth, the principles underlying active immunization, and the factors that enter into host-parasite relationships. Emphasis is placed on aspects related to the etiology, pathogenesis, epidemiology, and prevention of infectious disease. Special attention is also given to the principles underlying the induction and biological manifestations of the immune response. Offered every year in the first and second trimesters. Microbiology staff and invited lecturers.

Advanced Diagnostic Microbiology The lecture and laboratory sessions ac-

quaint the student with the procedures used in and techniques of management of a clinical microbiology laboratory. Emphasis is upon developing the student's capability in the isolation and rapid identificaiton of organisms from various types of clinical specimens. Liberal use is made of clinical materials available through the diagnostic laboratories of the New York Hospital. Offered every year in the third trimester. Hours by arrangement. Dr. Senterfit.

Microbiology Seminar Reports on surveys of the literature in the field and on current research. Presented by graduate students, faculty, and visiting scientists. Attendance is required of all students majoring or minoring in microbiology throughout their programs of study. Offered yearly and throughout the year. Dr. Sussdorf.

Other Academic Offerings

Clinical Microbiology Program—Ithaca and New York Campuses During the senior year of a special undergraduate study program on the Ithaca campus or during the year after receiving a bachelor's degree, the student may concentrate on developing skills in clinical microbiology at the Cornell University Medical College-New York Hospital in New York City. Students participate in courses concerned with microbiology, an introduction to infectious diseases, diagnostic microbiology, parasitology, immunology, and virology, in addition to working in the hospital diagnostic laboratory. This clinical microbiology specialization is designed to prepare students for employment in clinical microbiology laboratories. However, it could also be selected by students interested in further education or other careers. Dr. Senterfit.

Field of Neurobiology and Behavior

Field Director

T.H. Joh, Department of Neurology, Kips Bay Building, Medical College, (212) 472-5594

Faculty Representative

G.E. Gibson, Department of Neurology, Burke Rehabilitation Center, White Plains, NY, (914) 948-0050, Ext. 2291

The Field of Neurobiology and Behavior provides training in the study of the nervous system. It includes the disciplines of neuroanatomy, neuroembryology, neurophysiology, neuropharmacology, neurochemistry, neuroendocrinology, molecular biology, and neuropsychology and perception. The program of the Field emphasizes a multi-disciplinary approach to the study of the nervous system, based on the belief that future advances in our understanding of the

nervous system will be derived from the thinking and research techniques employed by more than one discipline. Toward this end, the program of the students entering the Field is planned in consultation with several staff members, and the students are expected to spend some period of time working closely with members of the faculty whose interests are related to theirs. In addition, there are regularly scheduled seminars in the Field during which various aspects of work in progress are presented and discussed. By these means, the students are afforded the broadest possible view of the Field during their total training experience.

The student majoring in Neurobiology and Behavior will be required to satisfy the requirements of the courses in neuroscience, statistics, and biomathematics, and two in the following areas: microscopic anatomy, physiology, biochemistry, and pharmacology. The student must also have two minors, at least one of which is outside the Field. In addition, participation in the seminar program and advanced course offerings is expected. While there are no language requirements, it is suggested that the student achieve mastery of a modern foreign language or a computer programming language. The student choosing Neurobiology and Behavior as a minor is required to participate in the neuroscience course and the seminar program as well as obtain any additional experience that the minor sponsor may suggest.

Applicants to the Field are expected to have had adequate undergraduate training in biology, organic chemistry, physics, and mathematics. Graduate Record Examination scores are to be submitted with the application. An interview with the applicant is considered highly desirable.

Courses

Neuroscience This is the basic undergraduate medical school course and is required of all major and minor candidates in the Field. It is a broadly based course and introduces the student to neuroanatomy, neurophysiology, and pertinent neurology. Third trimester. Drs. Brooks and Grafstein.

Neuroscience Seminar Current topics of neurosciences not included or minimally covered in the Neuroscience course, are examined in detail. The course is required of all major candidates in the Field and is an elective course for medical students. Third trimester. Drs. Brooks and Grafstein.

Advanced Neurobiology: Molecular Neurobiology and Neurochemistry This advanced neurobiology course is taught by selected faculty members of the Cornell University Medical College and Rockefeller University and introduces basic molecular neurobiology and neurochemistry as well as current research activities in the Field. Prerequisites: neuroscience and biochemistry. The course is required of all major candidates in the Field, and is an elective course for medical students. First trimester. Drs. Joh and Gibson.

Neuropharmacology (see Field of Pharmacology).

Field of Pathology

Field Director

J.T. Ellis, Department of Pathology, Room C-314, Medical College, (212) 472-5940

Faculty Representative

C.G. Becker, Department of Pathology, Room C-444, Medical College, (212) 472-5983

Pathology is the study of the causes and mechanisms of disease processes. The purpose of a graduate program in pathology is to provide individuals with a baccalaureate or medical degree with basic knowledge of disease processes through study of the disciplines of anatomic and clinical pathology and by learning modern techniques of biological investigation. It is hoped that a student completing this program will have both the information and technical skills to make significant inquiries into the nature of disease processes and to bridge the gap between classical, descriptive pathology and such disciplines as biochemistry and molecular biology.

The graduate program in pathology includes the observation of diseases in their various forms at autopsy and in clinical laboratories, and study and research in the areas of immunology and immunopathology, oncology, virology, cellular biology, and electron microscopy. It may also include study in advanced mathematics, physiology, biophysics, pharmacology, anatomy, cytochemistry and histochemistry, advanced biochemistry, genetics and microbiology.

New students are required to have completed mathematics through integral calculus, chemistry through organic chemistry (although physical chemistry is recommended), basic physics and at least general biology. A reading knowledge of at least one foreign language is suggested but not required. For those students entering the program with baccalaureate degrees only, the Graduate Records Examinations, including the Aptitude Tests and the Advanced Test in biology or chemistry, are required.

Graduate students in pathology are required to take the course in general and systemic pathology offered to second-year medical students. They must minor in at least one and not more than two other biomedical fields. Courses in biomathematics, biochemistry, genetics, and microbiology are also required.

Courses

General and Systemic Pathology Gross and histological lesions are studied and their pathogenesis and correlation with disturbed function considered. Lectures and classroom demonstrations are supplemented by studies at the

autopsy table. The course begins with cell injury, inflammation, and repairs. It then proceeds with the various specific infections and tumors. The latter part of the course is devoted to special systemic pathology, including an introduction to neuropathology. First and second trimesters. The staff.

Field of Pharmacology

Field Director

W.W.Y. Chan, Department of Pharmacology, Room E-400, Medical College, (212) 472-6029

Faculty Representative

M. Okamoto, Department of Pharmacology, Room E-411, Medical College, (212) 472-5975

The graduate program emphasizes sound basic training in general pharmacology. Then, by means of individual instruction, the candidate receives exposure to several specialty areas of pharmacology. The latter part of the graduate curriculum is devoted to research in an area of the candidate's choice.

An adequate preliminary training in organic chemistry, physical chemistry, biochemistry, and physiology is prerequisite to graduate work in pharmacology. Training in statistics is strongly recommended.

Applicants are required to submit Graduate Record Examination scores for the Aptitude Tests and the Advanced Test in biology or chemistry.

Courses

General Pharmacology The basic pharmacology course is offered to second-year medical students and to qualified graduate students. It consists of lectures, laboratory work, demonstrations, and seminars given during the first and second trimesters. The purpose of these exercises is to teach the principles of pharmacology. Detailed consideration is given to the parameters of drug action to provide the student with the fundamental concepts essential for the evaluation of any drug. Consequently, the scientific basis of pharmacology is emphasized. Prototype drugs, essentially considered systemically, serve to illustrate several mechanisms and parameters of drug action. Therapeutic applications are considered only insofar as they illustrate principles of pharmacology or drug hazards. Prerequisites: biochemistry and physiology. The staff.

Advanced Courses in Pharmacology

Molecular Pharmacology Fundamental principles governing the effects of chemicals on living systems are examined from the viewpoint of drug-receptor interactions. Several concepts are introduced including drug

selectivity, specificity dose-response, and receptor theory. Examples of receptor isolation and receptor-drug interactions are discussed in detail. Prerequisites: An adequate background in biology, organic and physical chemistry, and biochemistry is required. The staff and invited lecturers. Offered every third year. Minimum of 10 students. Not offered in 1984–85.

Immunopharmacology The course focuses on the fundamentals of immunologic cell reactions and explores the mechanism of therapeutic immunologic regulation. Topics include: inflammatory and allergic processes; mechanism of cell activation; mediator release and action; cyclic nucleotides and prostaglandins; lymphokines, interferons and thymic hormones; immunotoxicology; immunologic assays and use of biologics and drugs for immunotherapy. A background in immunology would be helpful but is not required. The course is offered jointly by the faculties of the Medical College and the Sloan-Kettering Divisions, and is offered every third year. Miminum of 10 students. Not offered in 1984–85.

Neuropharmacology The course offers neuropharmacology of highlighted drugs and chemical substances which affect central nervous system. Emphasis is placed on molecular mechanisms of drug actions on biochemistry and physiology of nervous tissue, focussing neurotransmitter mechanisms and cell membrane modulation as mechanisms, including neuropharmacologic agents which modify the neurotransmitter actions. Several concepts are introduced including drug selectivity, specificity dose-response and receptor theory. Prerequisites: Neuroscience required. General Pharmacology is recommended. Third trimester. Dr. Okamoto, Pharmacology and Neurobiology staff, and invited lecturers.

Other Academic Offerings

Research in Pharmacology Research opportunities may be arranged throughout the year for graduate students who are not majoring in pharmacology but who want some investigative experience in the discipline. Special opportunities are offered for work on the nervous and cardiovascular systems and in biochemical and clinical aspects of pharmacology.

Seminars The Field of Pharmacology offers seminars in areas of interest to the faculty and graduate students of the field. Seminars in clinical pharmacology and teaching rounds are held regularly throughout the year. The content, format and schedule of these seminars are determined each year on the basis of the number and backgrounds of the interested students.

Field of Physiology and Biophysics

Field Director

E.E. Windhager, Department of Physiology and Biophysics, Room C-508, Medical College, (212) 472-5229

Faculty Representative

T. Maack, Department of Physiology and Biophysics, Room D-407, Medical College, (212) 472-5281

Opportunities are offered toward the Ph.D. degree in several areas of physiology and biophysics. Ample space is available, and laboratories are well equipped to provide predoctoral training in a medical environment. Interested individuals are urged to contact the Field Director before preparing a formal application. Letters of inquiry should include a discussion of the educational background and indicate possible areas of emphasis in graduate study. There has been a tendency to encourage applications from individuals who have a probable interest in more than one of the areas of physiology represented within the Field.

Applicants must have completed introductory courses in biology, inorganic and organic chemistry, physics, and mathematics through the level of differential and integral calculus. Additional course work in these disciplines at the undergraduate level is encouraged. Applicants with otherwise exemplary records who lack certain course requirements will be considered for acceptance provided that they remedy their deficiencies while in training.

The course of study emphasizes the importance of teaching and research in the preparation and development of individuals for careers in physiology. This goal is achieved by a combination of didactic courses, seminars, and closely supervised research leading toward the preparation of a satisfactory thesis.

A special program of study will be developed for each student in consultation with his or her Special Committee. In addition to the general requirements set by the Graduate School for all fields, all candidates for the doctoral degree in physiology will be expected to meet the following requirements:

1. Evidence of a satisfactory background in neurosciences. Ordinarily, the course in neuroscience described under the Field of Neurobiology and Behavior, or an equivalent course, will be taken concurrently with the course in physiology and biophysics.
2. Satisfactory completion of the course in physiology and biophysics, or an equivalent course.
3. For majors and minors in the Field, a minimum of two elective courses in the Field ordinarily will be required, in addition to the course in physiology and biophysics.

Courses

Physiology and Biophysics Lectures and conferences in body fluids, bioelectric phenomena, circulation, respiration, and gastrointestinal function. Second trimester. Dr. Windhager and staff.

Lectures and conferences on kidney function, acid-base regulation, endocrinology, and metabolism; and a weekly laboratory on selected aspects of physiology. Third trimester. Dr. Windhager and staff.

Topics in Membrane Physiology This weekly conference is designed for Ph.D. and M.D.–Ph.D. students with a major or minor in Physiology and Biophysics. It is at a somewhat advanced level, especially in its quantitative approach to physiology. The aims of the conference are to train students in physiological concepts, to facilitate the understanding of lecture material in the physiology and biophysics course, and to establish close student-faculty contact. Second trimester. Dr. Andersen.

Selected Topics in Kidney and Electrolyte Physiology and Pathophysiology Lectures, seminars and demonstrations. Topics include: (1) GFR, clearance concept, reabsorption and secretion of electrolytes; (2) concentrating mechanism; (3) electrophysiology of the nephron; (4) pathophysiology of potassium; (5) renal blood flow and its intrarenal distribution; (6) renal physiology in the newborn; (7) control of body fluid volume and tonicity; (8) pathology and pathophysiology of renal failure; urinary sediment; (9) radiology of the kidneys; (10) dialysis; (11) transplantation. Third trimester. Maximum of 12 students. Dr. Windhager and staff.

Instruction at the Sloan-Kettering Division

Graduate Seminar This weekly graduate seminar is offered each year. During the first trimester, second-year students will present brief reports on their research experiences in the laboratory rotations. First-year students may report on laboratory rotations, review a selected area of research, or critically review a research paper. The discussion is carried out principally by graduate students under the guidance of their major (temporary or permanent) sponsors. From time to time outstanding authorities are invited as guest speakers. In addition, students in their third and later years of graduate study address the seminars on the progress being made in their thesis work.

Laboratory Rotations Throughout the year students should spend time in research laboratories. Arrangements for laboratory rotation should be made with the major sponsor.

Minor Projects Two minor subjects are required of all students and they may include some laboratory training, i.e., a minor project. The major sponsor assumes the responsibility for monitoring the time spent on the project. Minor subjects should be completed before the Admission to Doctoral Candidacy Examination.

Laboratory Safety and Biohazards Course All students are required to take by their second year the course of six basic lectures sponsored by the Sloan-Kettering Institute Institutional Biosafety Committee. The series covers general laboratory safety, the use of radioisotopes, carcinogens, primary and secondary barrier systems, contamination control, and hazards associated with research animals, and is supplemented by lectures on special topics given throughout the year.

Unit of Cell Biology and Genetics

Program Chairman

J.L. Biedler, Sloan-Kettering Institute, Walker Laboratory, Room 2127, (914) 698-1100, Ext. 243

Unit Chairman

D.B. Donner, Sloan-Kettering Division, Howard Laboratory, Room 909, (212) 794-7871

Students will spend their first year in: 1) satisfying course and seminar requirements; 2) participating in laboratory rotations; and 3) initiating one or two minor projects. The Unit Chairman will serve as temporary major advisor during this time. At the end of the first year the student's performance will be reviewed and a Special Committee of three members will be selected. The Special Committee membership must provide multidisciplinary academic backgrounds.

During the second academic year students should complete two minor projects, satisfy the requirements of the Admission to Doctoral Candidacy Examination and initiate a thesis project.

Prerequisites for a major in Cell Biology and Genetics include courses in chemistry (through organic), biochemistry, physics, mathematics (through calculus) and general biological sciences (botany, zoology, microbiology, cell biology); physical chemistry is recommended.

Submission of Graduate Record Examination results, in both aptitude and the advanced test in biology or chemistry is required.

Programs will be determined individually on the basis of interest and prior experience. Students are expected to have knowledge of materials offered in the courses of the Unit and in microscopic anatomy. Exemption from the courses can be granted following the successful completion of a written examination. Students majoring in cell biology may be advised to register for courses in molecular biology, genetics, biochemistry, and biostatistics.

Courses

Topics in Cell Biology Staff and invited lecturers will discuss the latest research in cell structure and function. Topics will include cellular organization, cell-cell recognition, cell growth and division (particularly contrasting normal and neoplastic development), differentiation, cell movement, and genetics and gametogenesis. The format will include a weekly 2–3 hour meeting with required reading of current scientific papers and student analysis of these papers. Second and third trimesters. Drs. Donner and Rosen.

Other Academic Offerings

Tutorial in Cell Biology and Biochemistry Designed to familiarize graduate students with fundamental concepts of cell biology and biochemistry. Topics will include cell structure, organization and function, intermediary metabolism, and molecular biochemistry. Hours will be arranged between small groups of students and faculty tutors. Dr. Eisinger and staff.

Endocrine Research in Progress Seminars Reports of on-going research by faculty of the Graduate School of Medical Sciences, Cornell University Medical College, and Rockefeller University are given weekly.

Flow Cytometry This brief tutorial will include lectures and demonstrations

on the principles of cell measurements and sorting as they are applied to basic cell biology, with special emphasis on nucleic acid content, cell cycle analysis, differentiation and transformation. Dr. Darzynkiewicz and staff.

Cell Culture Tutorial Instruction in tissue culture techniques will be offered to a limited number of students in laboratories of Unit members. Sessions can count as lab rotations or be expanded into minor projects. Dr. Biedler and staff.

Cellular Differentiation Journal Club A weekly informal discussion of recent publications or research of common interest in cell biology and differentiation. Participants are responsible for choosing a presentation for the week. Dr. Friedman and staff.

Unit of Developmental Therapy and Clinical Investigation

Acting Program Co-Chairman

J.J. Fox, Sloan-Kettering Institute, Walker Laboratory, Room 3037, (914) 698-1100, Ext. 225

Unit Chairman

F.M. Sirotnak, Sloan-Kettering Division, Kettering Laboratory, Room 316, (212) 794-7952

In this multidisciplinary program, opportunities for advanced study are focused on laboratory, clinical and/or statistical research as they relate to cancer prevention, diagnosis and treatment. Undergraduate prerequisites vary with the subspecialty area of training in which the student wishes to concentrate; the areas of study offered and their recommended undergraduate backgrounds are reviewed briefly below. Graduate Record Examination results in both the aptitude test and the advanced test in an appropriate area of concentration are required to be submitted by all applicants to the Unit.

1. Instruction toward the Ph.D. degree with emphasis in Biochemical and Molecular Pharmacology, Medicinal Chemistry and Biochemistry, Clinical Chemistry and Biochemistry, Cancer Therapeutics and Toxicology.

Undergraduate majors in biology, chemistry or health sciences are most appropriate backgrounds for admission. In addition, students should have adequate training in organic chemistry, physical chemistry, biochemistry and physiology. Training in statistics is recommended.

Course requirements include advanced instruction in cell and molecular biology, and courses appropriate to the subspecialty pursued by the student.

Other courses might include one or more of the following: Advanced biochemistry, microscopic anatomy, physiology, neurosciences, biostatistics and both general and advanced pharmacology. The program of study designed for each student will, in general, reflect the level of the student's undergraduate preparation.

2. Instruction toward the Ph.D. degree with emphasis in Radiation Biology, Radiation Physics, and Radiopharmaceutics.

Applicants should have a major in biophysics or a major in biology, chemistry, or mathematics, with training in general physics, electricity and magnetism, mechanics, mathematics (through calculus) and thermodynamics.

Students will be required to take advanced instruction in cell and molecular biology, and in physics, biochemistry and mathematics, depending upon the level of prior training.

Instruction toward the M.S. degree in Radiation Physics is also offered for candidates holding a B.A. or B.S. in physics. These candidates are expected to take advanced instruction in physics, biophysics, biology, radiobiology, biochemistry, and biomathematics with a minor in one of these subjects other than physics, and prepare a thesis in the field of radiation physics. The candidates for the M.S. degree must demonstrate a thorough knowledge of this area in a final written and oral examination.

3. Intruction towards the Ph.D. degree in Biostatistics.

The program is designed to provide training in statistical theory, methodology, and computing, combined with broad experience in data analysis and collaborative research with medical investigators. Admission to the program requires a B.S. degree in mathematical statistics, or the equivalent.

Courses to be completed by each student will depend upon the level of prior training and individual interests. In addition to basic probability theory and statistical inference, there is special emphasis on the design and analysis of clinical trials and the development of skills in exploratory data analysis. Each student participates in an internship program in statistical consulting and collaborative research. A doctoral dissertation in biostatistics involves the development of new theory or methodology under the direction of a faculty advisor.

Courses

General Pharmacology (see Field of Pharmacology).

Advanced Pharmacology (see Field of Pharmacology).

Radiation Physics, Lectures and Problems A series of lectures and assigned problems in applied mathematics, fundamentals of radiation physics, x-ray and radium treatment planning, diagnostic x-ray principles, radiation protection, and uses of radioactive isotopes. First, second, and third trimesters. Dr. Laughlin.

Biostatistics I: Introduction to Statistical Reasoning It is the aim of this course to help participants gain some insight into the theory underlying a probabilistic approach to the treatment of observational or experimental data, and to acquaint them with the most basic techniques of statistical analysis. First trimester. Dr. Groshen.

Biostatistics II: Experimental Design and Curve Fitting Application of concepts introduced in Biostatistics I to the analysis of scientific data. Topics include statistical design of experiments, analysis of variance, correlation, and linear regression. Second trimester. Drs. Groshen and Thaler.

Survival Analysis and Clinical Trials Parametric and nonparametric models of survival times, exponential and Weibull distributions; life-table and Kaplan-Meier estimates; design of randomized clinical trials, concomitant variables, stratification, sample size determination; 2- and k-sample techniques for censored data; generalized Wilcoxon and log-rank tests, Cox regression. Third trimester. Dr. Groshen.

Other Academic Offerings

Advanced Biophysics Laboratory rotations in various areas of radiation physics. Hours by arrangement. Dr. Laughlin.

Radiobiology Tutorial in fundamental radiobiology dealing with the effects of radiation on cells, viruses, and macromolecules, as well as on whole animals. Also covered are areas in radiation physics and radiation chemistry pertinent to radiobiology. Dr. Zeitz and staff.

Radiopharmaceutical Chemistry A tutorial in radiopharmaceutical chemistry is offered to those students majoring or minoring in this subject. Hours by arrangement. Dr. Gelbard and staff.

Biophysics Colloquia Reports on research in progress by faculty and outside lecturers. Required for majors in biophysics. Hours by arrangement. Staff.

Unit of Immunobiology

Program Chairman

O. Stutman, Sloan-Kettering Institute, Kettering Laboratory, Room 1118, (212) 794-7475

Unit Chairman

B. Dupont, Sloan-Kettering Institute, Schwartz Building, Room 711, (212) 794-6005

Programs are determined individually on the basis of interest, training, prior experience, and consultation with the student's Special Committee. The Unit has no fixed course work requirements other than those set by the student's permanent Special Committee. However, all students majoring in the program are expected to take full advantage of the Unit's core program of formal courses as well as to participate in additional course offerings of the Sloan-Kettering Division, Medical College Division, and other institutions which best complement their previous background and fulfill their scholastic objectives. Students will spend their first year in: 1) satisfying course and seminar requirements; 2) participating in laboratory rotations; and 3) initiating one or two minor projects. The Unit Chairman will serve as temporary major advisor during this time. At the end of the first year, the student's performance will be reviewed and a Special Committee of three members will be selected. The Special Committee membership will provide multidisciplinary academic backgrounds. During the second academic year, students should complete any minor projects required by the Special Committee, take the Admission to Doctoral Candidacy Examination, and initiate a thesis project. It is the clear intention of the Unit that extensive formal course work should not interfere with participation in the various other activities, such as rotations, tutorials and minicourses as well as seminars and lectures offered at Sloan-Kettering Institute and neighboring institutions.

Undergraduate prerequisites include a general college-level background in biology and other sciences, including a strong background in genetics, biochemistry and microbiology.

Submission of Graduate Record Examination results, in both aptitude and the advanced test in biology or chemistry, is required.

Courses

Immunology I This course is appropriate for, but not restricted to, students who have had no formal training in immunology, or who wish to review fundamentals in preparation for the advanced course, Immunology II. An overview of specific and non-specific immunity, cellular participants in immune response, structure of immunoglobulins and cell surface receptors, molecular basis of antibody diversity and cell-surface antigens, specificity of immune responses, methods for measuring humoral immune response, immunogenetics and transplantation immunology, and methods for measuring cell-mediated immune responses are among the topics which will be discussed. First trimester. Dr. Dupont

Immunology II Lectures, discussions and assigned readings for in-depth studies to cover properties of antigens and antibodies; mechanism of antibody formation; structural and functional aspects of the immune system; molecular basis of antibody and lymphocyte diversity; major histocompatibility complexes

in man and animals; immunogenetics of differentiation; effector mechanisms of antibody and cell-mediated immunity; immuno-deficiency disease; regulation and control of the immune response; immunological tolerance; immunology of transplantation, tumor immunology. Prerequisites for the course are at least one semester or equivalent of biochemistry and introductory immunology (Immunology I.) Second trimester. Dr. Lloyd.

Immunology III Lectures, discussion and assigned readings on subjects related to clinical immunology such as histocompatibility antigens; properties of T, B lymphocytes, and macrophages; lymphoid cell lines; immunopathology; immunodeficiencies; immunogenetics; organ and bone marrow transplantation; tumor immunology, etc. Prerequisites are introductory immunology (Immunology I) or equivalent course. Third trimester. Dr. Dupont and staff.

Other Academic Offerings

Colloquia In Immunology Informal sessions between students and senior faculty members to acquaint students with the major research programs headed by each of the faculty members of the Immunology Unit. Students from other units are also welcome to these sessions, which are announced monthly. The colloquia are open to all graduate students at all levels of training.

Laboratory Rotations, Tutorials and Minicourses In order to become familiar with the various research programs which are available to students doing major or minor work in immunology, the Unit advises entering students to participate in as many laboratory rotations, tutorials and minicourses as can be accommodated into the first-year schedule. The lists and decriptions for laboratory rotations, tutorial programs and minicourses are available from the office of the Unit Chairperson.

Unit of Molecular Biology and Virology

Program Chairman

R.M. Krug, Sloan-Kettering Institute, Kettering Laboratory, Room 406A, (212) 794-7475

Unit Chairman

K.J. Marians, Sloan Kettering Institute, Kettering Laboratory, Room 820A, (212) 794-5890

A good background in genetics, chemistry and biochemistry is required of students. Graduate Record Examination scores in both the aptitude test and the advanced test in biology or chemistry are also required. In the first two

years students are expected to complete a core curriculum that covers Graduate Biochemistry, Cell Biology, Immunology, Genetics, Molecular Virology, Molecular Biology and Gene Expression. All students are also required to take three seminars or advanced courses.

Courses

Molecular Biology The course presents the fundamentals of eukaryote gene structure, expression and regulation. Topics discussed include: DNA sequence organization, chromatin structure, viral and cellular RNA transcription, translation and its regulation, control of gene expression in model systems and molecular aspects of carcinogenesis. First, second and third trimesters. Dr. Sen.

Molecular Virology A formal course in which major emphasis is placed on the basic mechanisms in the biology of all animal viruses, including RNA and DNA tumor viruses. The topics considered include virus structure and composition, assay of viruses and viral-specific products, transcription and replication of viral nucleic acids, translation of virus-specific proteins, assembly of viral particles, structural and functional alterations in viral-infected cells including transformation, pathogenesis of viral diseases, and viral genetics. Alternate years. Dr. Krug. Not offered in 1984–85.

Molecular Biology of Neoplastic Transformation This course will focus on current efforts to understand the neoplastic cell phenotype from a molecular point of view. The effects of RNA and DNA tumor viruses on host cells will be discussed, in particular the transformation and/or differentiation blocks of defined cell lineages by certain agents. The nature and enzymatic specificities of viral gene products responsible for transformation will be compared with related products of normal cellular genes. The potential interaction of such products with regulatory systems controlling cell shape, adhesiveness, motility, and mitosis will be described, as well as the possible involvement of the same systems in nonviral neoplasias. At least part of the course will consist of student presentations on relevant subjects. Alternate years. Third trimester. Drs. Fleissner, Besmer, Hayward, and staff.

Advanced Nucleic Acids Enzymology. A formal course presenting the enzymological mechanisms and control of prokaryotic and eukaryotic transcription and DNA replication. Enzymes which alter DNA structure and shape are reviewed and topics in DNA repair and recombination are also covered. Graduate Biochemistry is a prerequisite. Third trimester. Drs. Marians and Hurwitz.

Register

University Administration

Frank H.T. Rhodes, President of the University

Robert Barker, University Provost

Thomas H. Meikle, Jr., Provost for Medical Affairs and Dean of the Medical College

William G. Herbster, Senior Vice President

Joseph M. Ballantyne, Vice President for Research and Advanced Studies

David L. Call, Vice President for State, Federal and Public Relations

William D. Gurowitz, Vice President for Campus Affairs

Robert M. Matyas, Vice President for Facilities and Business Operations

Richard M. Ramin, Vice President for Public Affairs

James A. Sanderson, Chief Investment Officer

Joan R. Egner, Associate Provost

Kenneth M. King, Vice Provost

James W. Spencer, Vice Provost

Walter J. Relihan, Jr., University Counsel and Secretary of the Corporation

Graduate School of Medical Sciences

Administration

Frank H.T. Rhodes, President of the University

Alison P. Casarett, Dean of the Graduate School

Bernard L. Horecker, Dean of the Graduate School of Medical Sciences, Associate Dean of the Graduate School

Dieter H. Sussdorf, Associate Dean of the Graduate School of Medical Sciences, Assistant Dean of the Graduate School

Richard A. Rifkind, Director, Sloan-Kettering Division

Dorris J. Hutchison, Associate Director, Sloan-Kettering Division; Associate Dean of the Graduate School of Medical Sciences, Assistant Dean of the Graduate School

Faculty

Alcock, Nancy W., Assistant Professor of Developmental Therapy and Clinical Investigation. B.S. 1949, University of Tasmania (Australia); Ph.D. 1960, University of London (England)

Allen, Fred H. Jr., Clinical Associate Professor of Pediatrics, A.B. 1934, Amherst College; M.D. 1938, Harvard University

Allfrey, Vincent G., Adjunct Professor of Genetics, B.S. 1943, City College of New York; M.S. 1948, Ph.D. 1949, Columbia University

Alonso, Daniel R., Associate Professor of Pathology. M.D. 1962, University of Cuyo (Argentina)

Andersen, Olaf S., Professor of Physiology and Biophysics. Candidatus Medicinae 1971, University of Copenhagen (Denmark)

Anderson, Lowell L., Assistant Professor of Developmental Therapy and Clinical Investigation. B.S. 1953, Whitworth College; Ph.D. 1958, University of Rochester

Artzt, Karen, Associate Professor of Cell Biology & Genetics. A.B. 1964, Ph.D. 1972, Cornell University

Bachvarova, Rosemary F., Associate Professor of Cell Biology and Anatomy. B.A. 1961, Radcliffe College; Ph.D., 1966, Rockefeller University

Bader, David M., Assistant Professor of Cell Biology and Anatomy. B.A. 1974, Augustana College; Ph.D. 1978, University of North Dakota

Baker, Harriet D., Assistant Professor of Neurology. B.A. 1963, Wells College; M.S. 1967, University of Illinois; Ph.D. 1976, University of Iowa

Balis, M. Earl, Professor of Cell Biology and Genetics. B.A. 1943, Temple University; Ph.D. 1949, University of Pennsylvania

Bancroft, F. Carter, Associate Professor of Molecular Biology and Virology. B.S. 1959, Antioch College; M.A. 1961, Johns Hopkins University; Ph.D. 1966, University of California at Berkeley

Bank, Arthur, Adjunct Professor of Cell Biology and Anatomy. B.A. 1956, Columbia University; M.D. 1960, Harvard University Medical School

Barany, Francis, Assistant Professor of Microbiology. B.A. 1976, University of Illinois at Chicago Circle; Ph.D. 1981, Rockefeller University

Becker, Carl G., Professor of Pathology. B.S. 1957, Yale University; M.D. 1971, Cornell University

Bedford, J. Michael, Professor of Cell Biology and Anatomy. B.A. 1955, M.A. Vet. M.B. 1958, Cambridge University (England); Ph.D. 1965, University of London (England)

Bennett, Dorothea, Professor of Cell Biology and Genetics. A.B. 1951, Barnard College; Ph.D. 1956, Columbia University

Berns, Kenneth I., R.A. Rees Pritchett Professor of Microbiology. A.B. 1960, Ph.D. 1964, M.D. 1966, Johns Hopkins University

Besmer, Peter, Assistant Professor of Molecular Biology and Virology. M.S. 1964; Ph.D. 1969, Eidgenössische Technische Hochschule (Switzerland)

Bianco, Celso, Adjunct Professor of Cell Biology and Anatomy. M.D. 1966, Escola Paulista de Medicina (Sao Paulo, Brazil)

Biedler, June L., Professor of Cell Biology and Genetics. A.B. 1947, Vassar College; Ph.D. 1959, Cornell University

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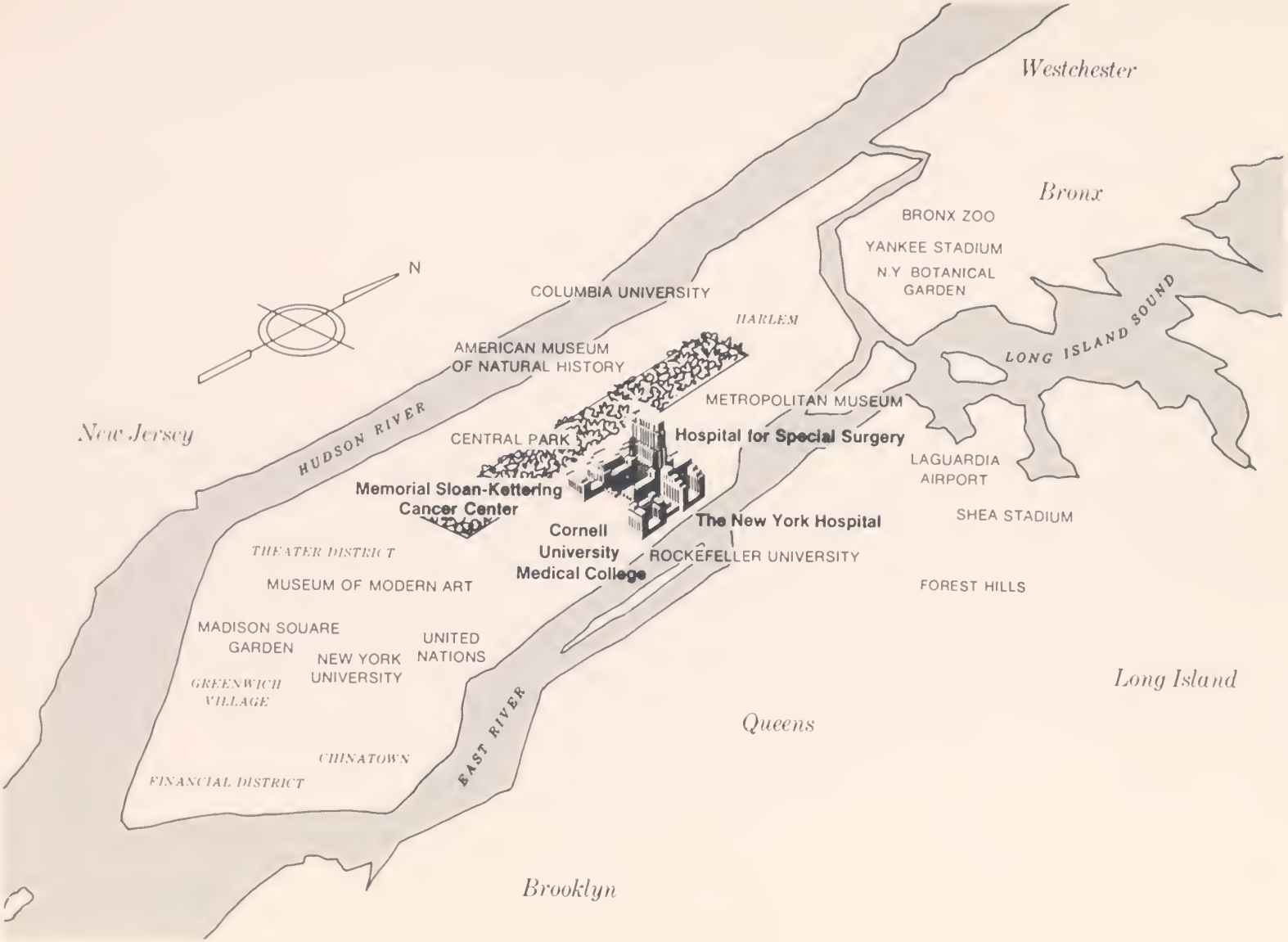
Westchester
Bronx
BRONX ZOO
YANKEE STADIUM
N.Y. BOTANICAL GARDEN
LONG ISLAND SOUND
N
COLUMBIA UNIVERSITY
HARLEM
AMERICAN MUSEUM OF NATURAL HISTORY
METROPOLITAN MUSEUM
New Jersey
HUDSON RIVER
CENTRAL PARK
Hospital for Special Surgery
LAGUARDIA AIRPORT
Memorial Sloan-Kettering Cancer Center
SHEA STADIUM
The New York Hospital
Cornell University Medical College
THEATER DISTRICT
ROCKEFELLER UNIVERSITY
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NEW YORK UNIVERSITY
Long Island
GREENWICH VILLAGE
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